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Vol. xxiii AUGUST, 1918 No. 8

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COMPRESSED AIR MAGAZINE

EVERYTHING PNEUMATIC

Vol. xxiii AUGUST, 1918 No. 8

OUR ENGINEERS IN THE WAR

By Gen. William M. Black*

Engineering in warfare has always been essential, and it is even doubtful whether the science of engineering does not owe its birth to the works of war. An engineer myself, I would be the last to be-little the work of our profession. It is a matter of pride that the men of our profession, because of the nature of their employment in time of peace, are, of all the civil professions, most prepared to serve the country in war; but to serve the country adequately in war the engineer must add to his peace equipment for professional work. There would be a great amount of effort saved if our people recognized more clearly the existence of the technicalities of the profession of arms. The government in Washington is simply deluged with suggestions and so-called inventions for the winning of the war. The records show that about ninety-eight per cent. of all these are without military value and that time and labor have been thrown away by men eager to help but entirely ignorant of the history and conditions of warfare.

NUMBERS OF ENGINEERS IN THE SERVICE

The part which engineers are now playing in the war is a very great one. The records of the American Institute of Electrical Engineers show that out of a total membership of 9,370 there are 850 in the service, or 9.1 per cent of its roster. The American Society of Civil Engineers, with 8,573 active members, has 14⅓ per cent in the service. The American Institute of Mining Engineers has 10.4 per cent, and the American Society of Mechanical Engineers 10.1 per cent. But these records are not complete. At the outbreak of the present war there were in the Engineer Corps of the regular army about 300 officers and approximately 3,500 enlisted men. At the present time there are about 8,000 commissioned officers and 200,000 enlisted men, made up of men formerly engaged in works of an engineering character. It is probable that this does not represent much more than one-half of the number of the profession now serving in the army.

DETAILS OF WAR ENGINEERING

Let us consider the nature of the work of the engineer, passing from front to rear of the army. First in importance is the work of the sappers. They go before and remove obstacles, clearing away obstructions, building bridges and roads, making the trench systems complete, mining, providing light, water, lines for supply (light railways or roads) and military mapping. In this category enter practically all of the branches of the profession. Further to the rear are found the construction and operation of railways; road and bridge construction; the construction of veritable towns for supply depots, with all their accessories, drainage, sewerage, lighting and water supply; construction of quarters and of hospitals; and furthest to the rear; the construction of the ports of debarkation with their wharves, storehouses, railway lines, yards and shops, all with their sanitary systems. Separate from these activities, but necessary for their supply, are the forestry troops who turn

*From an address by the Chief of Engineers, United States Army, at the Atlantic City convention of the American Institute of Electrical Engineers, June 27.

the growing timber into lumber of the dimensions required for the various services. Locomotive and car-shops also are performing essential services. Topographic corps, sound-ranging corps and camouflage corps are also among the varied activities of the engineers.

ENGINEER QUALIFICATIONS

What preparation is required for the fulfillment of these varied duties? For the actual technical work of construction or installation the civil training of the engineer should prove sufficient where the plans which embody the military features have been prepared or when the military technique has been learned and assimilated. A fundamental of this military technique is that the time element is to be considered rather than money cost and that the work must be done with whatever materials are available.

WHAT OUR ENGINEERS ARE DOING

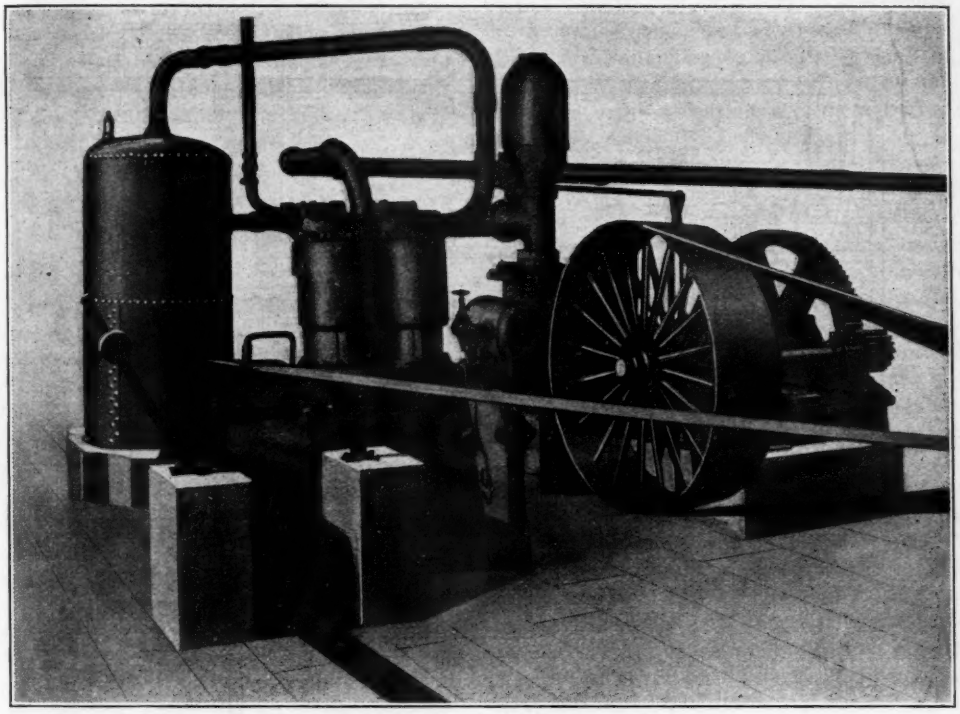
What have the engineers done? War was declared April 4, 1917. By the middle of July nine regiments of railroad engineers had been raised and organized and two had actually started for France. In each regiment were two officers of the Corps of Engineers of the regular army, the colonel and the regimental adjutant. The remaining officers were all from the Engineer Reserve Corps, some receiving their commissions only when on the point of sailing. Of course, few of the officers had had any previous military training and the tasks of organization were most difficult. Since then there have been organized five corps regiments, consisting of sapper, searchlight and sound-ranging troops; forty-three regiments and trains; two mounted battalions and trains; five pontoon trains; four inland-waterway companies; forty railway regiments and battalions, including all classes of standard gage and light railway troops necessary for the construction, operation and maintenance of railways; one railway transportation corps; one highway regiment; one gas and flame regiment; one gas training service; five forestry and auxiliary forestry regiments; one surveying and printing battalion; one military mapping service; two supply and shop regiments; one water-supply regiment; one quarry regiment; one mining regiment; one electrical and mechanical regiment; two crane-operating companies; one camouflage battalion; eighteen truck and auto companies, and forty-four depot detachments. The greater part of these organizations are now overseas. Some are serving with the British army, some with the French, but the majority are with our own troops, in service both at the front and in the rear.

AIR LIFT FOR HANDLING TAILINGS

BY H. A. CAMPBELL

Tailings from the mill of one of the largest copper companies in the Southwest are brought to a consistency of four or five parts of liquid to one of solid and allowed to flow by gravity through launders for about a mile where they then have to be lifted from 15 to 30 ft. and carried over a dam into a settling pond or dump. About 7,000 gal. per min. of this mixture is handled, and three 10-in. centrifugal sand pumps, direct-connected to 150-h.p. motors, were previously used. This method was found to be very expensive, as the tailings were sharp and cut out the casings and impellers of the pumps very rapidly, the average life of a pump not exceeding four days of continuous operation. Large motors were necessary, as the efficiency of the pumps dropped rapidly to a low point as wear occurred.

To obviate these difficulties, an air-lift system was installed and has proved a solution of the problem. At various points in the lower launder, openings were made discharging each into a 20-in. wood-stave pipe, which was set in a pit a sufficient depth to give proper submergence and closed at the lower end. Inside of this a 10-in. discharge pipe, fitted with a footpiece, is placed, through which air is introduced at the bottom and which discharges directly into the upper launder. This pipe has no bends and no obstructions inside, so very little wear can occur and renewal will be practically unnecessary. Three of these installations are able to handle the maximum tonnage. A separate compressor, driven by a 40-h.p. motor, is used for each air lift, although all three could easily be handled from a central plant if local conditions made it desirable. Compressors and motors are housed and require little attention. Operating costs and repairs have been cut to a small fraction of what they were with sand pumps, and the inconvenience of frequent shut-downs is eliminated.—*Eng. and Min. Journal.*



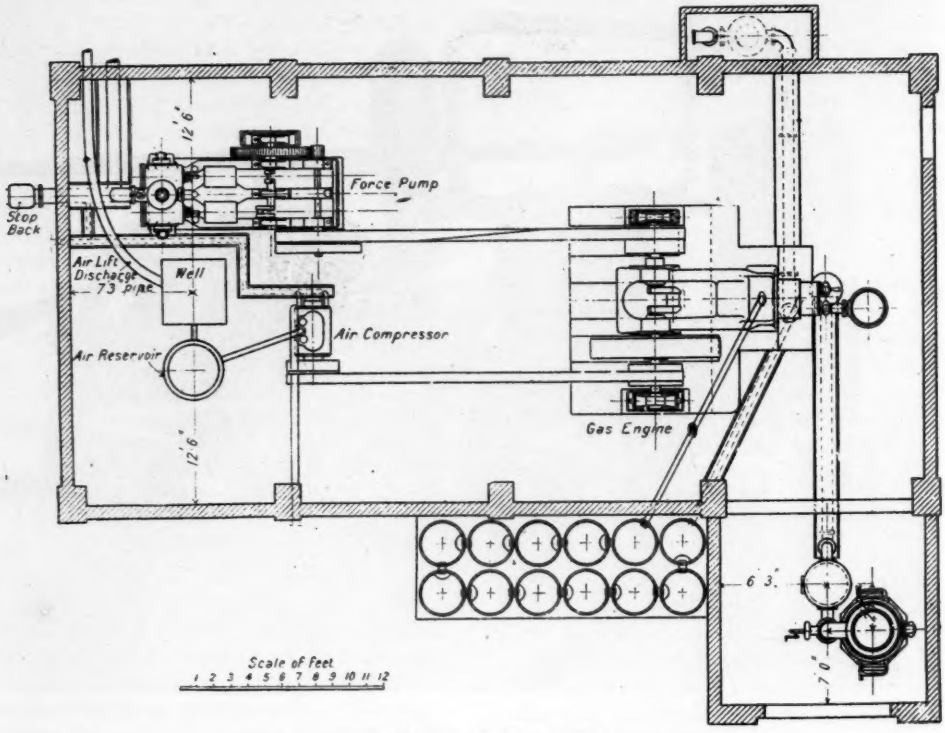
AIR COMPRESSOR AND PUMPS AT CURRAGH CAMP

AN AIR LIFT INSTALLATION AT AN IRISH CAMP*

An air lift pumping plant, combined with a set of two-throw surface force pumps, was recently supplied by Messrs. H. Brown and Co., of Princes-street, Bristol, for the Old Waterworks at Curragh Camp, County Kildare. Additional water being required, it was decided some little time ago to put down a bore-hole to a depth of 250 ft. from the surface. The particulars of the boring are as follows:—The first 25 ft. was sunk through gravel and fine sand, the excavation being eventually bricked with 9 in. brickwork, 3 ft. 9 in. square. From the bottom of this well the boring was first of all taken down to 75 ft. and lined with 15 in. inside diameter lap-welded mild steel screw-socketed tubes. Below this 15 in. tubing, 90 ft. of 12 in. internal diameter screw-socketed steel tubes were inserted, this lining being perforated with 1,400 ⅜-in. holes. A further 80 ft. of 10 in. internal diameter flush jointed well lining tubes were fixed below the 12 in. tubes, these 10-in. tubes being also drilled and having altogether 25,325 ⅜-in. holes in them. The whole of the perforations on both the 12-in. and 10-in. tubes are covered on the inside of the tubes by fine copper gauze, so as to form a sand screen to exclude the fine running sand with which the water is impregnated. Each series of tubes was fitted with a hardened steel cutting shoe.

The rest level of the water on the completion of the boring stood at 40 ft. from the surface. A pumping test of the yield of the well was made, the trial extending over a period of fourteen days' and nights' continuous pumping. It was carried out by means of temporary pumping machinery consisting of a direct-acting steam head of the single-cylinder type, the engine cylinder being 13½-in. bore by 36-in. stroke. The pump was placed at a depth of 85 ft. below surface level, and consisted of the usual type of bore-hole pump, 12-in. diameter by 3 ft. stroke, the valves being extractable from the surface and the bucket being worked by means of timber pump-rods. The rising main consisted of 13½-in. internal diameter steel tubes with screwed sockets. The dis-

*The Engineer, London.



PLAN OF PUMPING PLANT

charge from the pump was led into a tumbling bay, consisting of a box provided with baffling plates. The water escaped over a weir 12 in. wide, a constant stream 4⅝ in. deep being maintained practically throughout the test. In other words, the bore was found to be capable of yielding up to about 20,000 gallons per hour.

For the permanent machinery it was decided—owing to the expectation of a certain amount of sand being retained in the water—to utilize the air lift system of pumping for raising the water from the boring to the surface where it is discharged. It was at first intended to use four settling tanks formed of cement concrete, each tank being 25 ft. long by 11 ft. wide, and each provided with two penstocks actuated from the top of the tank by means of hand wheels for charging and discharging. In these tanks it was intended that the water should have time to free itself by settlement of any sand before being passed on to the force pumps. Eventually, however, it was found that so little sand was raised that the idea of the four tanks was abandoned, and only one large tank was constructed to receive the discharge of the air lift pump. The water is raised from that tank by horizontal duplex plunger pumps through 726 yards of 8 in. main and against a total head of 170 ft. into a water tower.

The air compressor and pumps are driven by a National gas engine, which gives 96 brake horse-power when running on suction gas from anthracite coal. The air compressor, which was built by Broom and Wade, Limited, of High Wycombe, is of that firm's usual vertical type, all the working parts being enclosed. The cylinders, which measure 10 in. by 12 in., are designed to deliver 200 cubic feet of free air per minute, at a constant pressure of 60 lb. to the square inch when the compressor is running at 200 revolutions per minute. The machine is fitted with an automatic air governor, the air being accumulated in a receiver constructed of steel plates and measuring 6 ft. by 3 ft. The compressed air is conducted to a depth of 245 ft. below the surface by means of 3 in. internal diameter steel tubes, and is discharged through a copper nozzle perforated with ⅜ in. holes, the air

pipes being run inside an 8 in. eduction main.

The surface pumps are of the duplex double-acting horizontal type, the plungers being 10¼ in. diameter by 15 in. stroke. They have a capacity of 20,000 gallons per hour, at a speed of 20 revolutions per minute.

CONTROL OF COMBUSTIBLE AND AIR IN BURNING POWDERED COAL

BY W. G. WILCOX*

Having considered the essentials of combustion, we can estimate the value of powdered coal as a fuel. In the same way we can ascertain also the conditions demanded for success in the combustion of pulverized fuel.

The simplest view of the combustion of coal is to regard it as a reaction between fuel and oxygen. It is a heterogeneous system; consequently the velocity of the reaction and its completeness will depend upon the surface exposed by the solid, the pressure of the reacting gas, and the intimacy of the mixture. By grinding an inch cube of coal so fine that 85% will pass a 200-mesh screen, we have increased the surface exposure from six square inches to approximately 1,800 sq. in. Thus we have increased the velocity of combustion 300-fold. By doing so, we have changed the characteristics of the fuel. We now have a fuel relatively 300 times more active than the inch cube of coal, a new type of fuel that has in it inherent possibilities not to be found in lump or slack fuel. By increasing the surface exposure 300-fold, we have speeded combustion proportionately. This carries with it a further effect. The increase in rapidity of combustion also increases the rapidity of heat evolution, and consequently quickly raises the temperature of the rest of the material. This rise of temperature, which is much more rapid than in the normal combustion of coal, will double the velocity of combustion for each rise of 10°C. The increased rapidity due to greater surface exposure and that due to temperature rise are superimposed so that a pulverized fuel affords a combustion that is hundreds of times faster than when burning lump-coal.

Having a finely-divided fuel it is possible to form a mixture of fuel and air so intimate that each small particle of coal is surrounded by the proper amount of air. In this condition, by maintaining the proper velocity of the air-current, the fuel can be carried into the furnace in suspension and there burned completely, efficiently, and rapidly.

It is, of course, a simple matter to mechanically control the amount of powdered coal delivered to the furnace in a given time. It is also possible to control the amount of air delivered with the coal. If, then, we deliver to the furnace an intimate mixture of air and powdered coal, and control the amount of coal-dust and air delivered, we have the prime essentials. The degree to which they are attained depends entirely upon how carefully we study the characteristics of the fuel before and during combustion.

The amount of coal-dust delivered can be controlled simply and positively by using a screw-feeder operated at variable speed. It is also a simple matter to control the volume of air admitted with the fuel; but the highest efficiency possible with this type of fuel will not be obtained unless we work out a correct way in which to mix a finely divided solid with the air.

A study of the methods for making such a mixture immediately shows that the methods commonly used in making a uniform mixture of two miscible liquids or a uniform solution of a solid in a liquid, or the methods used in mixing finely-ground solids are not only useless in this case, but will actually separate the coal-dust from the air. Ordinary mixing is done by agitation; this agitation is usually accomplished by baffling, stirring, shaking, or similar devices. When, however, such methods are applied to a mixture of gas and finely divided solid, the solid tends to separate by reason of its higher specific gravity. This, in fact, is the principle of the well-known cyclone dust-collector. Any mixing device that produces such agitation of the dust and air as to give a centrifugal effect will tend to separate, not mix, the air and the dust.

The importance of mixing the coal-dust and air intimately cannot be exaggerated. The rapidity of combustion is a direct measure of the intimacy of the mixture. This is well illustrated by comparing the ordinary gas-flame with the flame obtained in the Bone combustion system, which consists in forcing the proper proportion of air and gas through

*From a paper before the Western New York section of the American Chemical Society.

a diaphragm having numerous interstices. When this mixture is ignited on the other side of the diaphragm, it produces a film of flame.

The poorer the mixing, the longer the flame. The flame simply outlines the area in which combustion is taking place and the length of the flame is a measure of the time element necessary to accomplish combustion. This time element—other conditions being equal—is absolutely a function of the intimacy of mixture, as was noted by Breckenridge ten years ago, when in Bulletin No. 325 of the U. S. Geological Survey, he stated:

"The conclusion is reached that the velocity of combustion decreases enormously from the surface of the fire to the rear of the combustion-chamber, where it is relatively very small, the practical application is that little is to be gained by adding further length of smooth combustion-chamber, which would be commercially as poor an investment of capital, as to add to the length of a Corliss engine-cylinder and stroke; we must resort to thorough mixing."

Just as in the past there has been a remarkable failure to realize the necessity for intimately mixing air and coal-dust, so there has been insufficient consideration of the characteristics of this fuel when burning. Powdered coal has the characteristics of a rich fuel of somewhat higher kindling temperature than producer-gas, natural gas, or fuel-oil. To illustrate the fact that it is a rich fuel, we can compare the available B.t.u. in a cubic foot of a correctly proportioned mixture of powdered coal and air and the available B.t.u. in a cubic foot of correctly proportioned mixture of pure methane and air. Take a Pittsburgh coal (heating value 14,157 B.t.u) of the following analysis:

	%
Volatile	35.4
Fixed carbon	58.5
Ash	6.1

We find that a cubic foot of a correctly proportioned mixture of coal-dust and air has available 107 B.t.u., while a mixture of pure methane and the proper amount of air has available per cubic foot, 62.3 B.t.u.

The rapidity of combustion and the completeness of combustion of a mixture of coal-dust and air depend upon a number of factors: for example, they are dependent upon the velocity and pressure at which it is passed into the combustion-chamber. If the velocity of the incoming stream of powdered coal and air is above the velocity of flame propagation, combustion will not take place until the mixture has slowed down to a point that it does not exceed the velocity of fiame propagation. When a powdered coal is fired at high pressure and high velocity, combustion frequently does not begin until a point four to six feet from the mouth of the burner. A similar example is found in the plumber's blow-torch when too much air is used, or in the Bunsen burner when the gas-pressure is too high. High-pressure firing not only slows down combustion, thus increasing the size of the chamber necessary, but has a destructive action on the furnace. It has been well established that high velocities in the combustion-chamber or a blow-torch effect due to firing at high pressure (whether oil or gas be used as a fuel) are always destructive of the brickwork. This action is increased in high-pressure firing of powdered coal, since, in addition to the erosional effect of gases at high temperature traveling at high velocity, there is a fluxing action by the melted ash. Furthermore, the slagged ash will be carried along mechanically, leading to further furnace troubles. In one case this resulted in a deposit of slag on the mud-drum of a vertical waste-heat boiler at the end of a long reverberatory furnace. Slowing the velocity not only hastens combustion, but makes it possible to eliminate much of the slag. When the velocity is low the coalesced particles of slagged ash are either larger than will be carried by the velocity of the gas or this condition is so nearly approached that a slight change in direction of the flame will result in dropping out the slag. Thus, in addition to being correct combustion and necessary in order to avoid excessive furnace-maintenance costs, low-velocity combustion, by a slight change in flame direction, permits the dropping out of a large quantity of the slagged ash in the early part of combustion, where it can be removed and will not interfere seriously with efficient metallurgical operations.

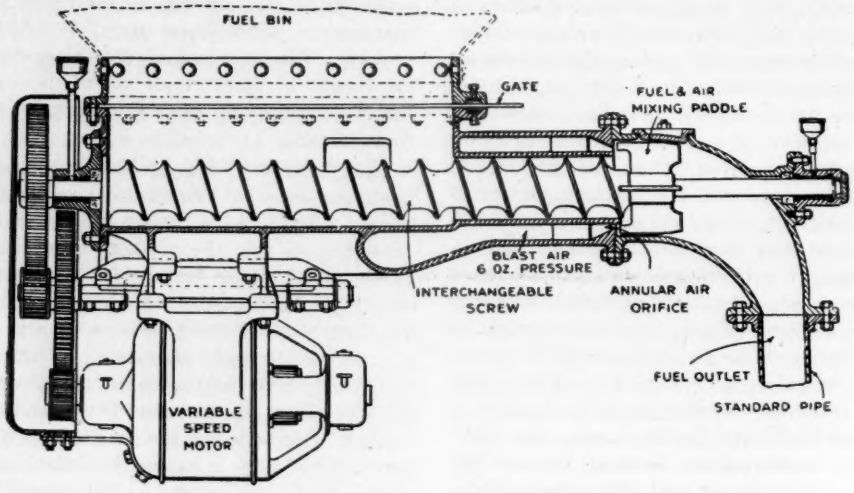
The velocity of combustion is not only dependent upon the fineness of the particles of coal, the intimacy of the mixture, and the velocity of the stream of combustible and air, but is affected by the temperature of the combustion-chamber. The kindling temperature

of a mixture of powdered coal and air is higher than that of either oil or gas; consequently for successful and complete combustion, it is necessary that the combustion-chamber be maintained above a certain minimum temperature and that the combustion be practically completed before the products of combustion pass over the heat-absorbing surface. Just as you can extinguish a gas flame by passing over it a piece of wire-gauze, so the effect of a chilling surface will be even more marked with this combustible material than with burning gas, since the particle of coal is infinitely larger than a molecule of gas and the kindling temperature is also higher. This has a direct application to the successful firing of locomotive boilers, water-tube boilers, and return-tubular boilers. If the combustion of powdered coal be not sufficiently developed before the flame enters the tubes of the locomotive boiler, combustion will be checked and coked coal settle out in the tubes. If, on the other hand, combustion be sufficiently developed before the flame is brought in contract with the heat-absorbing surface, complete combustion and high efficiency are obtained.

A study of the flame developed at a low pressure by an intimate mixture of coal-dust and air shows that combustion is extremely rapid. In a copper-reverberatory furnace at Florence, Colorado, where this type of combustion is used, coal burned at the rate of approximately one ton an hour develops a flame that vanishes within six feet of the burner, combustion being complete at that point. Let us translate this into terms of natural gas, in which case the fuel consumption would be approximately 26,000 cu. ft. per hour or 433 cu. ft. per minute. You can picture to yourself this quantity of gas being burned at low pressure and developing a flame only six feet long. Samples of gas taken in the flame show a content of CO_2 as high as 16% only five feet from the mouth of the burner. This will give an example of the rapidity with which combustion can be obtained and the possibilities of shortening the flame. With proper equipment it is equally practicable to lengthen the flame until it will spindle out a distance as great as 100 or 120 ft. However, with an intimate mixture under control, this must be done by supplying insufficient air. Under such conditions combustion is incomplete and the flame spindles out because combustion continues to develop throughout the length of the furnace as air-leakage supplies additional oxygen. This is proof of the statement that the length of flame is an actual measure of efficiency of mixing and the adjustment of the fuel-air ratio.

Thus, it is seen that we have changed entirely the characteristics of coal as commonly known. Powdered coal is a fuel of extreme flexibility, in that the amount burned can be varied within wide limits. It is a fuel that develops a flame whose length can be adjusted. The character of the flame can be altered to suit the metallurgical operation. In short, the basic fuel, coal, has acquired the characteristics of oil or gas, but with better and closer control. Furthermore, the possibilities of this fuel are not only capable of realization, but are actually being utilized in commercial practice to-day. To the flame characteristics of a rich fuel, developing a flame like oil or gas, is added a degree of control not yet obtainable in burning either oil or gas. This statement is made advisedly. The possibilities of such combustion for the improvement of processes, for fuel economy, for increasing output, through its ease of control and elimination of heavy labor, are realized by few. Owing to the attitude of labor and the scarcity of skilled operatives, it is far more difficult than ever before to secure high efficiency and good operation in hand-firing, stoker-firing, or in producers, in short, whenever such efficiency depends upon constant watchfulness and hot, heavy, disagreeable work. For these conditions powdered coal substitutes an ease of control such that the equipment can be handled by an old man or a boy, while it is so simple that a man of ordinary intelligence can soon be taught all that is necessary for good efficiency in operation. The possibilities of such control in the place of present-day combustion methods, which permit high efficiency only by the most strenuous effort, through substituting for these a type of combustion whereby high efficiency is easily obtained, are certainly of great importance to us at the present time.

Sulphur in Germany is being obtained at the present time almost exclusively by the reduction of gypsum. It is reported that deposits of anhydrite are similarly being utilized.



THE LOPULCO APPARATUS

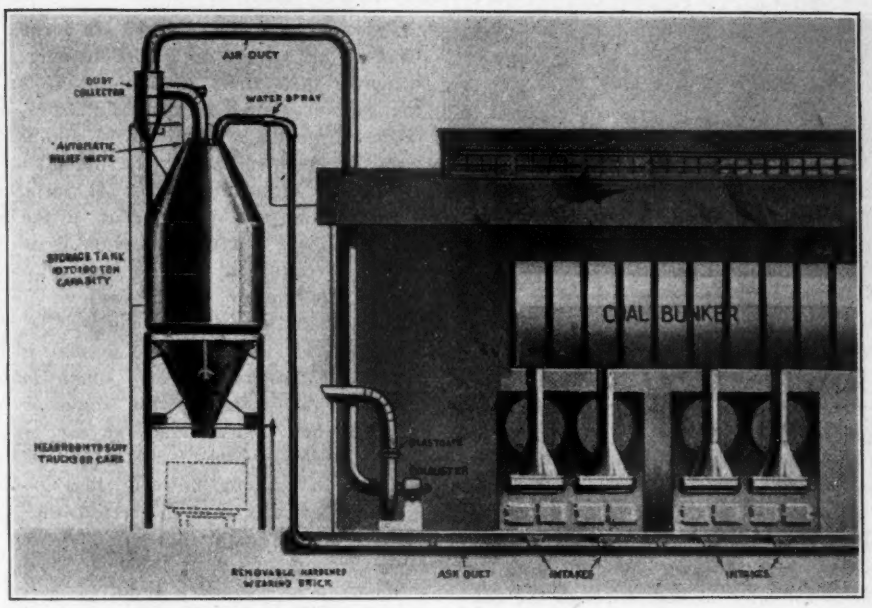
MIXER AND FEEDER FOR POWDERED COAL

The cut above shows the essential features of the "Lopulco" powdered fuel mixing and feeding apparatus of the Locomotive Pulverized Fuel Company, 30 Church Street, New York. It has been carefully developed and thoroughly tried out and has been found to be dependable under a wide range of conditions and with a great variety of conditions. It is of course applicable to stationary service as well as to locomotives.

The mechanism comprises a feed screw which serves to convey the powdered coal or lignite from the fuel bin to the mixer, where it is discharged into an air blast surrounding and concentric with the delivery end of the screw. The feed screw is driven through a train of reduction gears by means of a variable speed motor which makes feasible the modification of the rate of feeding to suit widely fluctuating power or heat requirements. As an example, the 5-inch feeder is capable of delivering fuel at a minimum rate of 850 pounds per hour and at a maximum rate of 3,400 pounds per hour, with 12 intermediate steps as may be required.

Attention is specially called to the applicability of this system for the relief of the New England coal situation. There are graphitic coal beds underlying portions of Rhode Island and Massachusetts north of Buzzards Bay which has been thought of little value as fuel, and the material has hitherto been mined chiefly for the recovery of the graphite of which it contains a large percentage. As a fuel it is high in both ash and moisture, and being more highly metamorphosed than is the anthracite in the Pennsylvania fields, it is entirely unsuited for use as fuel under ordinary conditions. In the pulverized form, however, it was found to burn readily as a substitute for Pennsylvania anthracite, the one observable difference being in the greater accumulation of ash which was to be expected from the nature of the fuel itself.

The availability of this fuel to industrial New England is a matter of all the greater importance in view of the difficulty which our coal producing and transporting facilities are having in meeting the reqirements of the different sections of the country. In view of this circumstance there is offered the possibility of a more dependable fuel supply for the New England mill district than that district was able to enjoy last winter. While, at the same time, the one million or more tons of fuel that went into that district from the Virginias and elsewhere would be conserved for other regions not having a native supply and the railroads would be relieved of the necessity of hauling that volume of coal through a territory where transportation lines and terminals are already seriously overcrowded.



GENERAL ARRANGEMENT OF SUCTION CONVEYOR FOR ASHES

SUCTION CONVEYORS FOR ASHES

BY REGINALD TRANTSCHOLD*

Particularly suitable for plants of considerable size is a system for handling ashes which utilizes the rush of air through a conveyor duct, or pipe, to an elevated storage tank, where a certain degree of vacuum is maintained by means of a high speed exhaust fan. This represents the most highly developed mechanical method of accomplishing the ash handling task. The conveyor proper consists of a heavy cast-iron, or steel, pipe running before the various boilers, under the boiler room floor, and in which small intakes are located for the receipt of the ashes from each boiler. This conveyor pipe continues out to an outdoor elevated storage tank into which the ashes are sucked. The various intakes leading to the conveyor duct are kept tightly closed, excepting when the conveyor is being actually charged with ashes.

When the conveyor is to be operated, the boiler man simply rakes the ashes to the intake, then he removes the cover and the rush of air through the opening toward the partly exhausted storage tank takes the ashes with it. The ashes are transported virtually in suspension, so there is relatively little abrasion caused by the swiftly moving ashes on any straight runs of the conveyor duct.

Whenever the direction of the conveyor duct changes, however, the flying ashes are impinged obliquely against the far side of the pipe, or connection, i. e., the elbow, with considerable force and the result is a severe scouring action which will, in a short time, wear through any elbow of ordinary construction. This abrasive wear is the chief cause of direct deterioration of suction conveyors.

To reduce it the elbows are made with removable backs of hard manganese steel, carborundum, reinforced glass, or other material possessing high resisting properties. These elbows are placed wherever the general path of the conveyor duct makes a change in direction, and so pronounced is the abrasive action of the fine particles of ashes that the hardest elbow is brought to a high state of polish in a short period of service. The polished surface then tends to reduce the rate of deterioration and, at the same time, to prevent loss of carrying capacity by any slowing down of the rushing air.

The exhaust fan creating the partial vacuum in the storage tank, removes the air from the top part of the tank. Between the exhaust connection and the discharge inlet of the con-

*Industrial Management.

RAKING ASHES INTO CONVEYOR

veyor duct a water spray plays on the ashes as they enter the storage tank, quenching them and precipitating the fine particles which would otherwise be sucked into the intake of the fan. As the operation of the system depends upon the success with which the air is exhausted from the tank, it is necessary that this exhaust tank be made air tight, with admission of air only possible through the conveyor duct, via the opened intakes in front of the boilers.

The ashes being carried in virtual suspension, the carrying capacity of a suction conveyor is quite limited, necessitating more continuous operation than equipment which carries the ashes in buckets or cars. A 4-inch suction conveyor, i. e., one with a conveyor duct of 4-inch pipe, has a carrying capacity but little over 2½ tons per hour, while a 12-inch conveyor, about the largest size employed, has an hourly capacity of somewhat less than 25 tons an hour. The capacity of conveyors between these limiting sizes varies directly as the square of the conveyor duct diameter.

The diameter of the conveyor duct, besides governing the carrying capacity of the system, governs also the size and power of the exhaust fan and, as the exhauster is the chief item of expense, the cost of an installation for one or two boilers is very nearly as great as the cost for one caring for a much larger boiler plant. Also, the consumption of power is nearly the same in a short conveyor system as in a long one of equal capacity. These peculiarities tend to limit the use of such methods of handling ashes to the larger plants where the high initial cost of installation and the cost of maintenance are discounted by continuity of operation made possible by the large quantity of ashes handled.

Provided no large clinkers are formed that have to be broken up before feeding to the conveyor duct, there is no question but that the suction system of handling ashes is the most convenient so far evolved, and is to be highly recommended for the plant that can afford the high initial cost of installation. When nothing unforeseen occurs in the boiler room and the suction conveyor is in good operating condition, the system is about as nearly "fool proof" as any system for mechanical handling of ashes can well be, for it is impossible for the careless fireman to force unbroken clinkers, or any other material which might choke up the conveyor duct, through such small intakes as are provided for the ordinary feed of fine ashes. There is one note of warning, however, that should be sounded, for, this point neglected, the highly efficient system might turn out as deadly as a German bomb.

Should it be necessary to pull an active fire in an emergency, a serious accident might occur were incandescent particles of coal passed into the conveyor duct. These glowing pieces lose little of their heat during their brief journey through the conveyor and reach the water spray at close to grate temperature. The still incandescent fuel may give off explosive coal gases and even disintegrate the water vapor, as in the case of a suction gas producer. These explosive gases collect in the pockets formed in the top part of the confined storage tank—despite the suction of the exhaust fan—and have been exploded with disastrous results by a piece of incandescent fuel sucked into the tank. The danger of such an accident is slight, it is true, but the seriousness of the danger makes its mention advisable—particularly as all risk can easily be avoided by the exercise of a little care. A timely word of warning: incandescent fuel should never be fed to the conveyor.

STEAM JET SUCTION CONVEYOR

Another system, one also employing the rush of air through a conveyor pipe, or duct, to carry the ashes in suspension, and one which is more suitable for a plant of small boiler capacity than the more expensive system just described, is a system in which a jet of live steam is directed into the conveyor duct at some point beyond the last intake for ashes —usually at about the point where the conveyor duct rises to elevate the ashes. The

steam jet, discharging in the direction of travel, creates a vacuum of 16 or 25 inches of water and induces a rapid flow of air through the conveyor duct, from any open charging intake. Such an installation will elevate ashes as much as a hundred feet, convey them over horizontal stretches of several hundred feet and up a reasonably tall section of vertical conveyor duct to the elevated storage tank.

The diameter of the conveyor duct is usually made 6 or 8 inches, and the capacity of the conveyors is usually about the same as that of the more elaborate suction systems, namely, about 5¼ tons per hour for the 6-inch conveyor and 10¼ tons for the 8-inch. To handle such a quantity of ashes, about 7 or 8 per cent. of the steam generated by the boilers cared for is required, but only while the conveyor is in actual operation. In one plant where careful measurement of steam consumption was made, 1,850 pounds of steam, under 110 pounds gage pressure, were required to handle 7 tons of ashes from four 400 horsepower boilers.

In this steam jet vacuum system, the ashes are usually allowed to accumulate in hoppers below the grates and only fed to the conveyor duct during periods when steam can safely be withdrawn from the boilers for the service of creating the required suction in the conveyor duct. The ashes are, therefore, usually comparatively cool when they pass through the conveyor and contact with the steam jet is sufficient to settle the fine particles of dust and deliver the ashes to the storage tank in a suitably quenched condition.

The wear at conveyor duct elbows, etc., is nearly as marked as in the vacuum system employing an exhaust fan, and deterioration may, in this second system, be somewhat aggravated on any horizontal or vertical stretch after the ashes have come in contact with the expanding steam by the formation of acid fumes. However, the storage tank in this system may be ventilated and so allow for the escape of fumes and any explosive gases which may be generated and carried into the tank.

AIR HELPS IN OIL WELL

The Carter Oil Company some time ago struck oil in the Towanda pool, Butler County, Kansas. It was reached by the drill at 2,396 feet and as far as could be told it was the same sort of formation and just as thick as the sand found in other wells in the district. The drill was sent 65 feet into the sand and the well started in as a steady producer at 3,000 bbls. It kept this up for 10 days and then suddenly the flow went up to big figures and it kept this rate for nearly two weeks. Then the flow began to dwindle and in four days ceased to flow any oil. The well was swabbed out and it began flowing again and in a few days it began to dwindle in production. Then the Carter officials decided to try the use of air. An air line was put down inside the casing. The line had numerous small perforations in the part standing in the sand. A compressor was hooked up and began pumping air down into the hole. In a single day the oil began flowing at a higher rate than even before and now is producing the fluid bountifully and promises to continue this production.

GASOLINE FROM CASING-HEAD GAS

Casing-head gasoline is made by two different processes, the compression process and the absorption process. In the compression process the wet gas is compressed by large machines to a pressure between 200 and 300 pounds to the square inch. The compressed product is then cooled and the "wet" parts of the gas condensed. The high-gravity product is then mixed with low-gravity distillates and kerosene, which can not be utilized by themselves in automobile engines. However, the addition of the light-gravity gasoline gives the resulting mixture a volatility sufficient to permit ready combustion in automobile motors.

The absorption process of making gasoline may be used for casing-head gas or for gas that does not occur with the oil. This process is based upon the fact that when the wet parts of the gas are forced through certain kinds of oil used for absorption, the oil absorbs the light particles of gasoline carried by the gas. These are later recovered from the oil by heating it, the gasoline being driven off and the high-gravity product being condensed. The product of the absorbers is blended with a heavier distillate as is the product from compressing casing-head gas.—*Yearbook of the U. S. Bureau of Mines.*

EXPANSIVE FORCE OF QUICKLIME

Some interesting particulars regarding the expansive force exercised by quicklime under the action of moisture have been communicated to the *Ironmonger*. Quicklime, as is well known, develops, when wet, an enormous expansive force that acts slowly, and, consequently, has peculiar mechanical advantages. Efforts to utilize this force have been successfully employed recently to break up heavy brick masonry. Several piers, 12 ft. by 20 ft. on plan, and 12 ft. high, were situated between similar foundations on which were fixed machinery which could not be disturbed. The problem was to break up the masonry no longer required without damage to the rest of the plant. Blasting was inadmissible, and handcutting and breaking too slow and expensive. The work was accomplished by drilling 3 in. vertical holes 3 ft. deep and 3 ft. apart in both directions over the entire area of the piers, and filling them within 6 in. of the top with lumps of fresh slacked lime which was thoroughly wetted. The tops of the holes were then filled with brick drilling well tamped, and in about ten minutes cracks started in every direction, and the entire top of the foundation pier was broken into 3 ft. cubes.

"LAUNDRIES" FOR AIR BRAKE PUMPS

The cut upon the opposite page with the following descriptive matter is from a report presented at the recent annual convention of the American Air Brake Association telling of the means employed on the Minneapolis, S. Paul and Sault St. Marie R. R. for cleaning the air brake pumps or compressors without taking them down or in any way dismantling them.

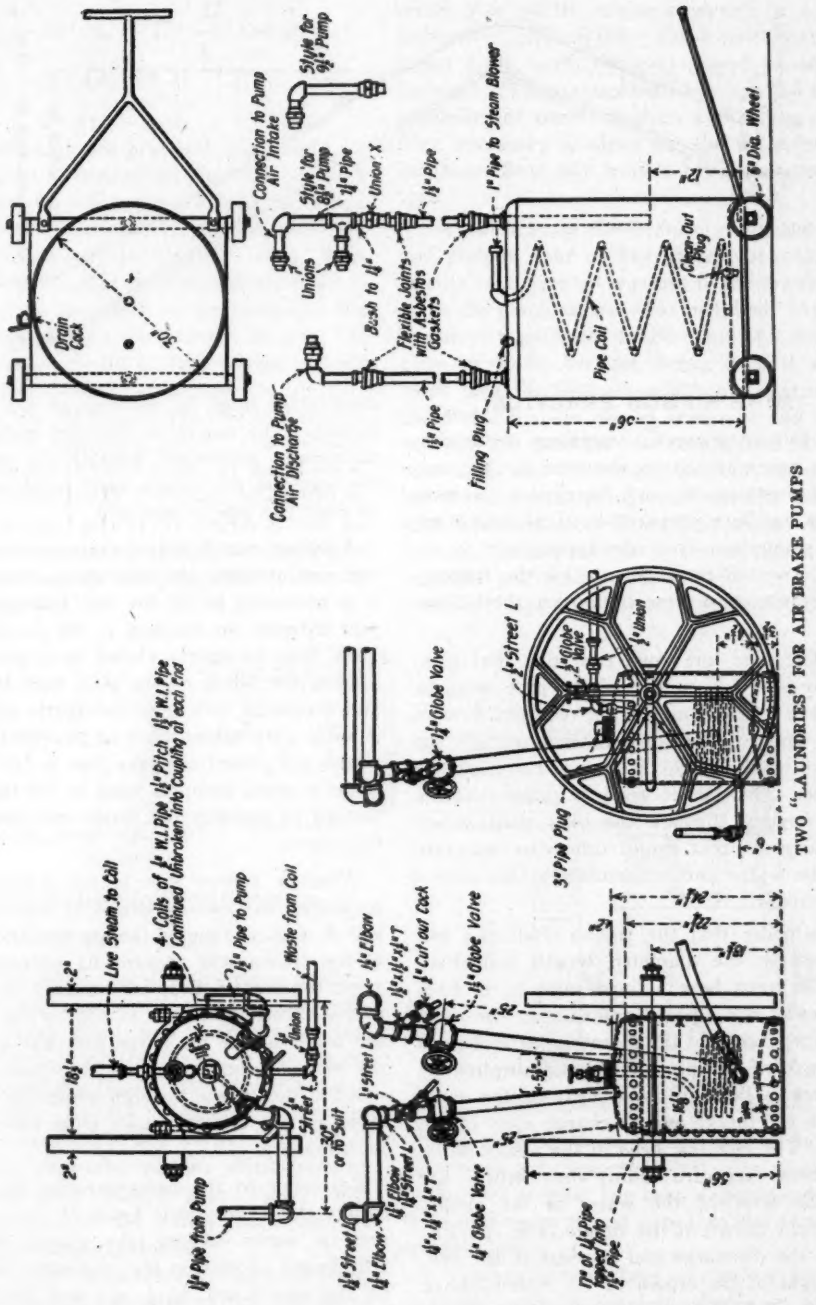
Dirt entering the cylinders of an air compressor destroys lubrication and increases the wear of packing rings and cylinder walls. The dirt and worn-off metal, coupled with heat of compression, form the hard gum so frequently met with; hence, excluding dirt will improve lubrication and reduce wear and gumming. Clogged and gummed passages and ring grooves of the compressor are responsible for a portion of the trouble, such as reduced efficiency, pounding, running lame, slow speed, etc.

A very effective and economical way to remove this deposit is by means of the compressor "laundry," which should be used every three months or so, depending on the service and protection afforded the compressor against dirt. The illustration shows two types of air compressor "laundry" outfits, as developed by the Soo Line Ry. They consist in general of an enclosed tank mounted on wheels, for a lye solution, a steam pipe coil inside the tank and suitable pipe connections to join the tank to the suction and discharge openings of the compressor. The solution should consist of about one pound of concentrated lye to one gallon of water, and should be kept hot by steam circulating through the coil while the compressor is being cleaned.

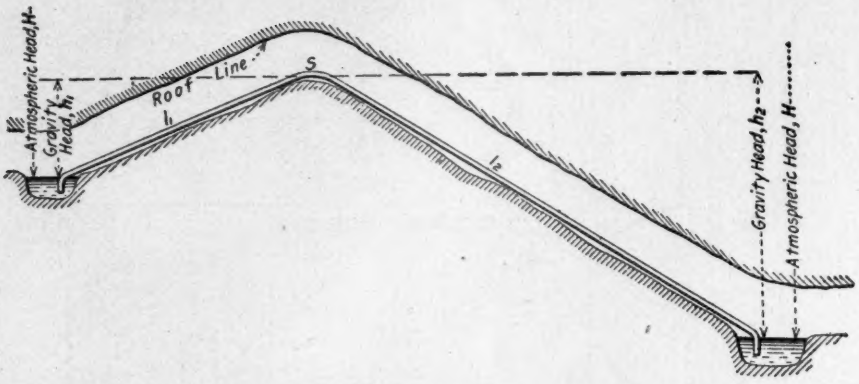
To operate the outfit first see that the air cylinder piston rod packing is tight, then remove the air strainers and disconnect the discharge pipe at the compressor. Connect the supply and return pipes from the "laundry" to the compressor air cylinders, also a steam line to the steam coil. After the solution is at or near the boiling point, open the compressor throttle and permit the compressor to operate at slow speed with the solution circulating through the air cylinders and discharging back into the tank.

The length of time the compressor should thus operate depends on its condition, but usually from two and one-half to three hours give the best results. After the compressor has been thoroughly cleansed the tank connections should be removed. Clean water (hot water is preferable) should then be worked through the air cylinders for several minutes, discharging into the pit, to insure all of the solution being removed, after which the compressor should run idle until all the water is worked out of the cylinders. The air cylinders should then be well lubricated, the strainers re-applied and the discharge pipe connected. If soft packing is used the air ends may need to be repacked.

The method here outlined for removing the gummy deposits from air cylinders of a compressor is far superior and more economical than to cut it out with chisel and scraper. When the old method is used it comprehends much labor in the removal and replacement of lower cylinder heads and air pistons, and then the ports only can be cleaned. After the "laundry" outfit is connected to the compres-



sor it does not require an attendant during the two and one-half or three hour period mentioned, other than an occasional visit to observe that all is going well. A solution of about ten gallons mixed as herein mentioned will be sufficient to cleanse about five compressors, other than the possible exception of adding lye to maintain its strength.



MINE SIPHON PRACTICE

The following careful statement of the conditions necessary to be observed for the successful installation and operation of mine siphons has been prepared by *Coal Age* in reply to a question by a correspondent.

The essential requirements for the successful operation of a mine siphon are the following:

1. The pipe line must run full; that is to say, the size (diameter) of the pipe must be such that it will conduct the required flow of water, under a velocity determined by the effective head and the frictional resistance of the pipe. This is necessary in order that the water flowing through the pipe shall sweep away any air that might otherwise separate from the water and accumulate at the crown of the siphon.

2. In order that the siphon shall run full continuously, the diameter, length and effective head must bear a fixed relation, in both branches of the pipe. For example, the ratio of the fifth power of the diameter, in inches, to the length of the pipe, in feet, multiplied by the effective head, in feet, must be the same for both the intake and discharge ends of the siphon. The *effective head* at the intake is the atmospheric pressure minus the vertical lift from the level of the water in the supply basin to the crown of the siphon. The *effective head* in the discharge end is equal to the vertical height of the crown of the siphon above the point of discharge minus the atmospheric pressure.

3. There must be no leaky joints in the pipe, and all unnecessary obstructions, in the form of sharp bends in the pipe, valves, and other hindrances must be avoided as far as practicable. The mouth of the pipe must be kept sufficiently submerged beneath the surface of the water in the supply basin to permit no air to enter the pipe at that end.

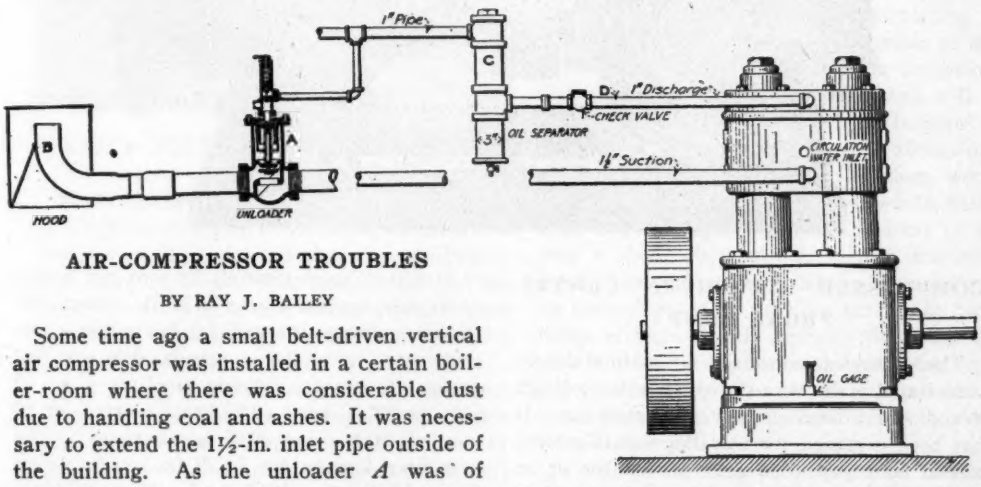
A siphon that fulfills these requirements will run continuously. In order to start the siphon, it is necessary to fill the two branches of the pipe through an opening at the crown, which must then be tightly closed by a good valve. During the filling of the pipe, both the intake and discharge ends must be tightly plugged or suitable gate valves must be provided at these points and closed until the pipe is full. Sometimes a small pump is used to fill the siphon instead of pouring the water into the pipe at the crown.

When a siphon line is not properly proportioned, as here explained, it will empty itself in a short time or the accumulation of air at the crown will prevent its operation. To avoid the first of these conditions it is common to use throttling valves to control the flow of the water at the discharge end, and to escape the second condition an air trap must be provided at the crown, through which the accumulated air can be withdrawn from time to time as necessary.

Referring to the accompanying figure and calling the atmospheric head, H, expressed in feet of water column, the gravity head, in feet, length of pipe, in feet, diameter, in inches, on the intake end, h_1, l_1, d_1; and, on the discharge end, h_2, l_2, d_2, respectively; the effective intake head is H-h_1, and the effective discharge head h_2-H. The relation of these elements, as stated in the foregoing rule is then expressed by the formulas

$$(H - h_1)\frac{d_1^5}{l_1} = (h_2 - H)\frac{d_2^5}{l_2}; \text{ and } d_1 = \sqrt[5]{d_2^5 \frac{(h_2 - H)l_1}{(H - h_1)l_2}}$$

These formulas are practical and should always be used to determine the sizes of pipe best adapted to different conditions regarding the length and vertical lift, or rise and fall, in each branch of the siphon. Also, it is well to remember that the atmospheric head H will depend on the depth of the mine and the system of ventilation employed. In practice, a good aneroid should be first compared with a standard mercurial barmometer on the surface, and then taken into the mine where the increase in the reading is noted. The increase, if any, is added to the reading of the barometer on the surface and the result multiplied by 13.6, the specific gravity of mercury, and divided by 12 to reduce inches to feet, will give the atmospheric head H, expressed in feet of water column.



AIR-COMPRESSOR TROUBLES

BY RAY J. BAILEY

Some time ago a small belt-driven vertical air compressor was installed in a certain boiler-room where there was considerable dust due to handling coal and ashes. It was necessary to extend the 1½-in. inlet pipe outside of the building. As the unloader A was of sensitive construction and as the least bit of dirt would make the pistons stick, causing poor regulation, considerable power was wasted because of the safety valve on the receiver releasing continually.

It was desired to connect the pipe as direct to the compressor and with as few fittings as possible, which located the end of the suction pipe between the eaves of three roofs. To keep it free from water and other obstructions, a hood was made, as shown at B, from 6-in. galvanized sheet-metal pipe with a 2-in. sheet-metal pipe on the inside soldered to a 2-in. galvanized pipe nipple. These parts were all taken from used material found about the factory. This arrangement has worked satisfactorily for nearly a year, and it has never been necessary to clean out the unloader nor has there been any trouble from poor regulation.

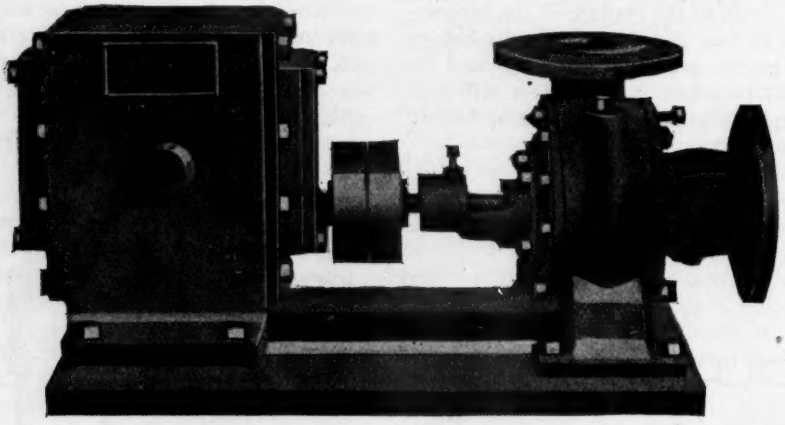
For lubricating the cranks, crosshead pins and pistons, four or five gallons of a certain quality of engine oil was put in the crank case when the machine was first installed. After a few days the oil was found unsuitable for this class of work, because, being thin, it would work past the pistons—which are exposed at the crank end—to the oil reservoir and about one pint per ten-hour run would pass through the valves and discharge pipe, burning on the valve stems and springs and causing them to stick and hold away from their seats. A portion of the burned oil would work into the unloader and make trouble.

An oil separator C was made from pipe fittings and two 3-in. nipples, each 6 in. long. A special air-compressor oil was used, and no further trouble has been experienced; less than one ounce of oil gets into the separator in thirty days.

Considerable advantage was gained by using a check valve in the 1-in. discharge pipe D when it was necessary to shut the machine down to examine the valves or to do work on the machine under pressure. It also serves to take the strain off the discharge valves due to the hammering effect when closing.

Several swing checks were used, which lasted but a week or ten days before the disk and seat had to be faced off and fitted so they would not leak. A horizontal globe check valve was then used, with the disk guided by a stem above and another below the seat. After being in service about four weeks, an examination showed that the stem and guide under the disk had worn away, the disk and upper stem and guide being in fairly good condition.

A check valve of the dashpot type is recommended as the best for this service, in which the upper part of the valve disk is connected to a dashpot, which will prevent its slamming. —*Power.*



COMPRESSED AIR-DRIVEN CENTRIFUGAL PUMP

The portable compressed air turbine-driven centrifugal pump here shown is built by Hugh Wood and Company, Newcastle-on-Tyne. It has been designed for handling small quantities of water up to 90 gals. per minute up to heads of 80 ft., and comprises a single-stage centrifugal pump coupled direct to a compressed-air driven turbine, both mounted on a cast-iron bedplate, the over-all dimensions being 24 in. long by 12 in. wide by 12 in. high, and the weight about 2½ cwt.

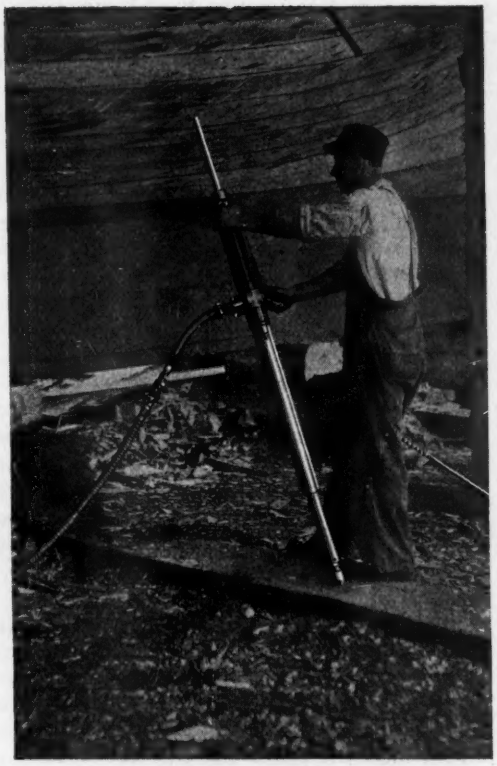
The small weight and size enable the set to be readily moved, and the compressed air drive, which is safe and simple, makes it specially suitable for collieries, shipyards, etc.

The turbine is of very simple construction, having no delicate valves, etc., in its construction, which consists primarily of two rotors, with stepped teeth, mounted in ball bearings, to obviate wear and repairs. The only valve is that for the air inlet, which is connected to the ¾ in. hose pipe. The turbine works satisfactorily at any air pressure between 50 and 100 lb. per sq. in., and develops up to 5 h.p. The speed is automatically adjusted to that required for the head and quantity.

The pump is a single stage Sulzer centrifugal pump, and is connected to the turbine driving shaft by a flexible coupling of the rubber pin type.

Run at a speed of about 3,020 revolutions per minute, the pump will deliver 95 gals. at 74 ft. head (approximately 24 tons per hour), or 50 gals. against a head of 80 ft., power consumption being 3½ and 2.3 horse-power respectively. For lower speeds delivery and power are correspondingly smaller—e. g., 65 gals. at 21 ft. head (0.95 horse-power), or 50 gals. at 24 ft. head (0.85 horse-power). The maximum suction lift is 20 ft. for deliveries up to 50 gals., and 18 ft. for 65 to 95 gals. per minute. The suction and delivery nozzles are about 2½ in. inside diameter.

Comparative evaporation of coal, oil and gas, according to the United States Geological Survey, is as follows: Under favorable conditions 1 lb. of oil will evaporate from 14 to 16 lb. of water from and at 212 deg., 1 lb. of coal will evaporate from 7 to 10 lb., and 1 lb. of natural gas will evaporate from 18 to 20 pounds.



A DRIFT-BOLT DRIVER FOR WOODEN SHIPS

While shipbuilders are bending every effort to speed up each step of ship construction, the builders of the tools that play so important a part have not been idle. Their task is the development of new and better machines, so that a few seconds may be cut from the time required for each operation.

The latest contribution is an air hammer especially designed for drifting up bolts. This tool enables one workman to do in a short time that which would otherwise be a relatively slow task needing two men. There is also the consideration that the new hammer makes the work far less fatiguing.

The tool in question is styled Ingersoll-Rand No. CC-251 Drift Bolt Driver. Its distinguishing feature is a telescoping leg or air feed. This portion of the device consists of two sections of seamless steel tubing, one of which slides within the other and is provided with an air tight cup leather. Air when admitted extends the tool until it is against the bolt to be driven, where it is firmly held by air pressure while the bolt is being driven. A single three-way throttle controls both functions of the tool.

The hammer element is identical with that of the No. CC-25 Drift Bolt Driver. The new tool is very powerful and will drive bolts of 1½-inch diameter up to 10 feet long. It weighs 90 lbs., is 55 inches in length when air feed is closed and 77 inches when fully extended.

In its special field it is of distinct advantage and should be a welcome addition to the air tool equipment of the yards turning out wooden hulls.

HOW BIG A COMPRESSOR TO BUY

BY LEE A. KNIGHTS

In selecting an air compressor for the new mine, quarry or contract, the first consideration is naturally to determine what machines or tools and how many are to be operated by the air power.

Practically all handbooks on compressed air, and many manufacturers' catalogues, have for many years contained tables purporting to show the air consumption of a number of different drills of various sizes. It is obvious that a table cannot be prepared that will be correct for all conditions, as, for instance, if eight drills were working in two headings of a tunnel it is probable that all of them would be working at the same time and would, therefore, require eight times the amount of air that a single drill would. If, on the other hand, eight drills were scattered around over an excavation to be used for putting in "pop" holes, it is extremely unlikely that over five or six would ever be working at the same time, so a compressor supplying five or six times enough air for one drill would be ample to take care of the entire eight.

A little reflection will show that the only factors that need to be seriously considered in estimating the requirements to take care of a number of drills are the air consumption of each drill and the greatest number of drills that will be operated at one time. If the air receivers are of exceptionally large capacity, they may be counted on to assist materially in carrying the peak load, but under the majority of conditions the receiver capacity may be disregarded, as receivers are usually only large enough to equalize the fluctuations in pressure due to the pulsation of the com-

pressor, and serve merely as equalizers and not as storage reservoirs.

In comparatively large installations, by which is meant those of twenty or more drills, the compressor capacity may be estimated from the probable average reciprocating time of the drill. For instance, if fifty drills are to be installed, and it is expected that each one will be actually running 75 per cent. of the time, the air required will be 75 per cent. of the amount of air one drill takes, multiplied by 50. This method of estimating should only be used for comparatively large installations. For instance, if two drills are to be installed, which will probably run 75 per cent. of the time, it is, of course, necessary to furnish compressor capacity enough for the two instead of one and one-half, since both would be working at the same time. This method of estimating should never be used unless the probable lost time of the drills is equal to at least one drill. That is, 75 per cent. of 2 equals 1½; 75 per cent. of 3 equals 2¼; 75 per cent. of 4 equals 3. Therefore, we could expect only three drills out of four to be working on the last mentioned installation, and could, therefore, plan on compressor capacity enough for three drills. We cannot, however, assume 2¼ out of 3, as it is evident that either two or three drills will be working and so it would be necessary to have enough air to run the entire three.

OTHER AIR USES

In addition to the actual requirements of the drills or other main installation of machinery, a liberal allowance should be made for use in other machines, such as pumps, motors and forges, and also for leakage. It is folly to attempt to discourage the legitimate use of compressed air, for this is a very economical and efficient method of transmitting power and accomplishing certain results, but great emphasis should be placed on the unnecessary waste of it, especially by leakage.

LOSSES FROM LEAKAGE

Very few people fully realize the losses due to leakage of compressed air. A hole one-sixteenth of an inch in diameter will cause a loss of about six cubic feet of free air per minute at 100 pounds pressure. A one-eighth-inch hole will allow a loss of over 25 cubic feet per minute, or enough to run a small tool. A quarter of an inch hole will allow over 100 cubic feet per minute to escape, or enough to run a modern rotating hand hammer drill or a stoper. It is seldom that the leakage from a quarter of an inch hole would go unnoticed, but a multitude of smaller leaks are frequently allowed, which reduce the total efficiency of the installation to an almost unbelievable extent.

It is only necessary to run the compressor through the noon hour, or at some other time when no machines are working, to see just how many revolutions the compressor has to make to take care of leakage alone, since at that time no effective work is being done. If it requires 50 revolutions of the compressor per minute to keep up the pressure with no machines running, it is evident that if the compressor is normally running at 200 revolutions per minute, only 150 of the revolutions are furnishing air for efficient use, and the other 50 are merely taking care of the leakage. Unfortunately this test is very likely to leave one with a rather unsatisfactory opinion of the plant, but it serves the useful purpose of impressing one with the necessity of making a liberal allowance for leakage in future installations, and, still more important, makes it easy to keep leakage at the minimum, by checking up this loss from time to time, as machines are added and pipe lines extended. The above considerations of course apply to compressor plants wherever and for whatever service installed.—*Granite, Marble and Bronze.*

GASOLINE FROM NATURAL GAS BY COMPRESSION

BY W. P. DYKEMA*

Plants treating natural gas for its gasoline content fall under one of three mechanical and physical subdivisions—compression, refrigeration, and absorption, or a combination of these methods. Each division varies widely in mechanical details of both equipment and operation. Gasoline recovery by compression and refrigeration will be discussed in the following pages. Recovery by absorption methods has been described in Bulletin 120.

THEORY OF PRECIPITATION—CONDENSATION BY COOLING

The theory of the precipitation of vapors from natural gas is in a way comparable to that of the precipitation of water vapor from

*From Bureau of Mines Bulletin 151.

the atmosphere. Water vapor is known to exist in the air at all times in varying proportions, but is invisible unless condensed by cooling. Cooling to a temperature below that at which the air is saturated with the water vapor it contains causes precipitation in the form of snow, hail, frost, rain, fog, or dew. This fact is also illustrated by beads of water collecting on the outside of a pitcher of ice water, and by the formation of frost on the refrigeration pipes of expansion units. The air coming in contact with the cold surface of the pitcher or pipes is cooled below its dew point and the moisture which it can no longer hold as vapor condenses as water or frost on the surface. By further cooling of the air more moisture would be condensed, and if cooling were carried far enough practically all of the water vapor could be precipitated without the aid of pressures higher than atmospheric.

CONDENSATION BY COMPRESSION

In plants compressing air it is found that air, after having been made more dense by increase of the pressure and decrease of the volume, deposits moisture at atmospheric temperature, and as the pressure is increased larger percentages of the contained water vapor are precipitated. Hence either high pressures or low temperatures increase the condensation of the water vapor.

In the exceedingly dry atmosphere of the Arizona and Nevada deserts, operating air compressors at a pressure of 100 pounds and cooling the compressed air only to atmospheric temperature always causes precipitation of water, and of lubricating oils from the cylinders, in the air receiver. That all of the moisture in the air is not deposited in the receiver is shown by the fact that in pumps driven by compressed air some moisture freezes in the cylinders and also forms frost in the exhaust outlet.

The condensable fractions in natural gas, like those in air, are not visible under ordinary conditions, but at times the sudden release into the atmosphere of gas from confinement under pressure will cause vapors of hydrocarbons to form a mist resembling fog or steam.

In the treatment of natural gas for gasoline recovery the result desired could be accomplished either by compression or refrigeration, but the complex mixture of gases and vapors complicates the problem. Without an exact knowledge of the various members and the proportion of each to the whole, an attempt to calculate the most suitable pressures and temperatures becomes little better than a guess, and the most practical solution is by tests and experiments. According to the law of partial pressures, if gas contains 10 per cent. of condensable vapor and is under a pressure of 200 pounds, the condensable 10 per cent. has acting upon it a partial pressure of 20 pounds, or 10 per cent. of the total pressure. As the proportion of different condensable vapors in the gas becomes smaller through their partial condensation, the partial pressure acting on them also becomes less. The percentage of gage pressure acting on any one of the gas or vapor constituents varies in proportion to the percentage of volume occupied by that constituent. If the constituent is condensable, condensation will lower its proportion to the volume of uncondensed gas to a point at which the partial pressure acting on it is too small to cause further condensation, leaving a portion of the vapor uncondensed throughout the entire treatment. As the acting pressure becomes lower, condensation tends to cease, but lowering the temperature will cause further condensation. Under constant gage pressures and decreasing temperatures, the largest percentage of the heavier hydrocarbons contained in the gas is recovered, and the losses are confined to the lighter members.

Although all of the condensable vapor and even the true gases can be liquefied by increasing the pressure or reducing the temperature sufficiently, the application of these processes in treating natural gas for gasoline is limited by the commercial considerations. Extremes of either pressure or temperature would yield condensates too volatile for commercial use, also the machinery and other equipment required would be expensive to install and difficult to operate and maintain.

To recover the valuable hydrocarbon fractions that are held as vapors in natural gas, only such pressures and temperatures are necessary as can be obtained by the use of machines and fittings of standard construction and capacities. As the power used to compress the gas heats it, developing power by expanding the compressed gas cools it. By using the cooled gas as a refrigerant, the

temperature necessary, in conjunction with the pressure obtained, to extract the maximum of commercial condensate can be developed.

The temperature and the pressure that will yield the most profitable results are those that together will recover the largest possible amount of condensates of low vapor tensions and as much of the lighter parts as can be so blended or handled as to conform with legal standards of safety and make a good motor fuel.

ABSORPTION THEORY

The absorption process for recovering condensate from natural gas is based on an entirely different physical property, that of the solubility of vapors in liquids. In this process the gas is brought into intimate contact with a liquid which dissolves or absorbs the vapors; these vapors are later distilled from the absorbing medium and condensed.

USE OF COMBINATION COMPRESSION AND REFRIGERATION PROCESS

As shown above, the fundamental principles of the compression process are compression and cooling of the natural gas to pressures and temperatures at which certain hydrocarbons condense.

Plants of this character are erected to treat casing-head gas from oil sands or from sands closely associated with oil, the gas being brought to the surface either between the casing and tubing of an oil well or with the oil in the tubing. The quantity of gas from each well is usually comparatively small and in some installations as many as 500 or 600 wells are connected with one compression plant of not more than the average capacity.

The dry (treated) gas is, at most plants, used on the oil leases to drive the gas engines of the compression plant, and also for gas and steam engines in pumping and drilling wells. A few compression plants sell the treated gas for commercial use in cities or for manufacturing purposes. The cost of pipe lines and equipment necessary to deliver the small quantities of gas to market would, in general, be excessive. There is seldom much gas left after the quantity necessary for furnishing power has been used.

WHEAT HOLDS THE YEAST BUBBLES

When Mr. Hoover told the bakers of the country last winter that they must forthwith begin to make their bread with twenty-five per cent. substitution of other cereals than wheat the country at large thought very little of it. It created no flurry and there was much commendatory comment. The bakers would go ahead "per instructions," we'd get bread plenty good enough; and we'd send more wheat to Europe. Good!

But everyone forgot about *gluten*—everyone, that is, but the unfortunate bakers. Bread won't rise without enough of it. Wheat has it. Corn and most other grains have practically none of it. Rye has a little. When, therefore, Ira Hanks, of Hanksville, who runs his bakery by rule of thumb and bakes his bread in the good old way, tried to take out twenty-five per cent. of the wheat flour and substituted, say corn, the result was something that would have disturbed the digestion of a Harlem goat. It didn't rise. It was solid and soggy. Brother Hanks lost many a wrathful customer. People went home to roll their own. In short, none but the scientific bakers, with modern machinery, and the technical knowledge necessary to utilize all the gluten in that seventy-five per cent. wheat flour that remained, were able to make a go of it.

The reason, of course, was simple. Gluten is sticky. When the gas from the fermented yeast begins to generate in the dough of wheat flour, the abundant gluten holds it in; bubbles form, and the dough "rises." Try it with any cereal which lacks gluten, and it won't rise. The gas escapes.

A wheat base is therefore necessary for the making of palatable light bread. If the wheat flour in the bread be insufficient to furnish enough gluten the bread won't rise.

Fortunately, however, wheat flour contains an excess of gluten. Everyone knows, for instance, what used to happen when mother let the bread rise too long. The pans overflowed and the bread was too light. By reason of this fact, there is enough gluten in seventy-five per cent wheat flour to make a light loaf *if* all of it or nearly all of it be released into the dough by breaking down as many of the starch cells of the flour as possible, particularly if care be taken not to knead the gas out by improper handling. In the words of one baker, "The call was for high power mixers that would not expel the gas. The theory was to use the dough a little 'younger,' whip hell out of it, and bake it quickly."—*The Nation's Business.*

THE AIR LIFT HELPS ARTESIAN WELLS

By E. R. Conant*

Haphazard location of the river station group of artesian wells at Savannah, Ga., put in use in 1887-1889, resulted in a supply which soon became inadequate and led to the sinking of the Gwinnett group. The last-named artesian well system was designed by Thomas F. Johnson, Chicago. The 25 river wells were put down at random over an area of 10 acres. The 12 Gwinnett wells were sunk 300 ft. apart on a line at right angles to the direction of the subterranean flow. The Gwinnett wells have a diameter of 12 in., a depth of 500 to 600 ft. and are cased down into rock, some 250 ft. The wells are connected with a 6-ft. brick conduit 10 to 16 ft. below ground level, which discharges into a small well from which water is pumped directly to the distributing mains.

The first artesian wells in the Savannah district antedated the river station wells by five years. The water from these wells rose to from 30 to 35 ft. above mean low water. There are no early records of the static head in the river station wells but their diminution in yield indicates that the head was lowered 20 to 25 ft. within three years of the time they were put in use.

The Gwinnett wells are 3900 ft. from the river wells. When the first of these were sunk in 1890 their static head was about 28 ft. above mean low water. In 1893 the head was 12 ft. lower, and in 1898 it was 5 ft. lower still. There is no record of the head when the air lift was installed in 1902. In fact, the static head was not carefully determined until 1915, when the writer found it to be 10 to 12 ft. below mean low water—a drop of 22 ft. in 17 years, or an average drop of something less than 1½ ft. a year.

When the 12 wells at the Gwinnett station were put in use, in 1892, they yielded, by natural flow, 10,300,000 gal. a day. This fell to 9,500,000 gal. in a year or two; to 5,500,000 gal. by 1895 and to 5,000,000 gal. in 1900, where it remained until the installation of the air lift in 1902. Tests made by the author in 1915 showed a daily yield of 15,000,000 gal. At present 8 of the 12 wells yield 10,000,000 gal. a day.—*Engineering News-Record.*

*Chief Engineer City of Savannah.

"HISSING" AIR COMPRESSORS MAKE WOOD "CARVINGS"

[The following account of an unfamiliar operation comes to us from the always beautiful and interesting **Edison Monthly.** We feel compelled to suggest that the hissing of the compressors does not speak well for their operative efficiency.]

The reader, like the rest of confiding humanity, has marvelled perhaps at the amount of wood carving that shows today on portrait frames, mirror frames, lamp standards, mouldings, and all this gilded orgy of foils and curlicues. Without doubting its genuineness for a moment, the average mortal has wondered where in the world so much and so excellent carving could possibly come from.

While there are several sources, one at least—and an electrical one—is found shaping and pruning away in West Thirteenth street.

Though knives, broad bladed affairs a foot long, have something to do with it, the "carving" in this case is done on an upper floor to the tune of the hissing of motor driven air compressors. That is to say, the wealth of delicate detail that is made here, later to be mounted on wood, is formed under pressure in wooden moulds. The substance itself is a secret mixture closely resembling putty in color and consistency. A liberal lump is placed in a mould and the whole is set on the pan of one of the presses. In a moment down comes the upper pan with some thousand pounds force, and when the pressure is released and the composition freed, there are your curls and rosettes as natural as life.

The knives spoken of shave these carvings from their pasty background as they are needed, and skilled fingers fit them foil by foil to the wood work awaiting them. A little gluing, a little more shaping, and the moulding is "carved" to the sum of artistic completeness. Some actual carving—and very fine work, too—is produced here, yet by far the most is accomplished in the manner described.

Another new oil well has just been brought in in the Alamo district, near Panuco, Mexico, which at a depth of 2115 ft. yields about ten thousand barrels daily. The first indication of oil was encountered at 1860 ft.

WE'VE GOT TO DO WHAT WE CAN

Said Michael O'Leary to Patrick McCreery,
"You sure make me weary the way that you work;
Last week you lost one day, and this week—on Monday—
You laid off completely. Bedad, ye're a shirk!"
Said Patrick McCreery to Michael O'Leary,
"Well, what if I did?—and I did, it is true—
If I grab off a play-day or two around pay-day
I guess it's my business and nuthin' to you!"

Said Michael O'Leary to Patrick McCreery,
"Me son is a soldier who's fightin' in France;
He's got to have trifles like helmets and rifles,
Or else with the boches he won't stand a chance.
He needs to have batteries—guns that'll shatter his
Enemy's trenches before an attack—
And motors to carry his camp commissary
And ships that'll bring him the things he may lack.

"But when you are shirkin' yer job, or ain't workin',
You're holdin' him up on his arms and supplies;
For, get this straight, neighbor, when you slack your labor
You're doin' more harm than a half dozen spies.
Ther's need for the keenest of work—each machinist
And fireman and blacksmith should stick to the job
In war-time conditions to make the munitions
To help smash the Kaiser and all of his mob.

"And so," said O'Leary, "your ways make me weary;
You throw down me son as he fights Over There;
To loaf is a bum thing—you bet it means something
To me when you're slackin' from doin' your share!"
Said Patrick McCreery to Michael O'Leary,
"I never have thought of it that way before;
But now that I see it I sure will agree it
Ain't me that'll loaf on the job any more!"

—*American Machinist.*

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OUR DETERMINATION

"There can be but one issue. The settlement must be final. There can be no compromise. No half-way decision would be tolerable. No half-way decision is conceivable. These are the ends for which the associated peoples of the world are fighting and which must be conceded them before there can be peace:—

"I. The destruction of every arbitrary power anywhere that can separately, secretly and of its single choice disturb the peace of the world; or, if it cannot be presently destroyed, at the least its reduction to virtual impotence.

"II. The settlement of every question, whether of territory, of sovereignty, of economic arrangement or of political relationship, upon the basis of the free acceptance of that settlement by the people immediately concerned, and not upon the basis of the material interest or advantage of any other nation or people which may desire a different settlement for the sake of its own exterior influence or mastery.

"III. The consent of all nations to be governed in their conduct toward each other by the same principles of honor and of respect for the common law of civilized society that govern the individual citizens of all modern States in their relations with one another, to the end that all promises and covenants may be sacredly observed, no private plots or conspiracies hatched, no selfish injuries wrought with impunity, and a mutual trust established upon the handsome foundation of a mutual respect for right.

"IV. The establishment of an organization of peace which shall make it certain that the combined power of free nations will check every invasion of right and serve to make peace and justice the more secure by affording a definite tribunal of opinion to which all must submit and by which every international readjustment that cannot be amicably agreed upon by the peoples directly concerned shall be sanctioned.

"These great objects can be put into a single sentence. What we seek is the reign of law, based upon the consent of the governed and sustained by the organized opinion of mankind."

OUR PRESIDENT.

THE NAVAL CONSULTING BOARD IN ITS RELATION TO THE NAVY DEPARTMENT

Speech by W. L. Saunders, American Institute of Mining Engineers Dinner, Washington, D. C., June 21, 1918.

I have been given ten minutes to speak of the Naval Consulting Board; five is quite enough. I speak, alas, as one of experience when I say that a single sentence on this subject might stir up more trouble (for the speaker) than a ton of T. N. T. About a year ago, when I was only a freshman, serving the Government for glory and a dollar-a-year, I let fall a prophesy. Prophesy is dangerous tramping ground for the tenderfoot. I said that American inventive genius would solve the submarine menace and that the Naval Consulting Board had already made substantial progress in that direction. Forthwith I fell into the hands of the Philistines—in modern times called newspaper reporters. When it was all over and I had recovered consciousness a Red Cross nurse seemed to be holding a glass of Jersey lightning to my lips. There is a story of an English Tommy who was convalescing from his first dose of trench warfare. A visitor at the hospital asked him to describe the wonderful sensation of being in a battle. He said, "First you 'ear an 'ell of a noise, then you 'ear the nurse say, 'You better drink a little of this.'"

Well, I fear that the German submarine, like the liar, the thief, the murderer and the rattlesnake, will be always with us in this war; but thanks to the English and American navies, aided by civilian workers, this dishonest practice no longer threatens starvation or disaster to civilized nations. The British Prime Minister is my authority for the statement that the submarine is no longer a menace, but is still a nuisance. Mr. Arthur Pollen adds that it is an awful nuisance. I should call it a damnable nuisance.

As to the part taken by the Naval Consulting Board, I quote from the recent Annual Report of the Secretary of the Navy:

"The work of the board, organized and approved by Congress in 1915, has increased very materially in importance and volume. Some time before the active entry of this country in the war the board called a special meeting to which were invited some fifty of the leading scientists and industrial managers, whose special study fitted them to advise on the methods of meeting the submarine problem. Plans were immediately made to investigate every field to develop a means of preventing destruction of vessels and of defeating the U boat. The investigation was divided according to the experience of the different members and associated scientists; and with the co-operation and valuable assistance of the various manufacturing companies interested, a highly developed system of team work has been attained and results accomplished not dreamed of at the beginning of the war," and again, "Valuable assistance has been rendered merchant shipping by the board's activities. Through its initiative, counsel and work the U. S. Shipping Board formed its Ship Protection Committee, taking over the study of the protection of merchant ships, and to this Committee was detailed one of the Consulting Board's most experienced members qualified in shipbuilding and with sea experience. In this field the board's work has resulted in materially reducing the shipping risk, with a consequent lowering of marine insurance rates."

The board has stimulated interest in war problems. It has stirred a patriotic spirit and effort among inventors. More than 65,000 suggestions and plans have been considered and acted upon.

Our relations with the bureau chiefs and other officers of the Navy are most cordial. Individual members of the board, like naval attaches, are from time to time called into action to aid an executive in designing or building something of value in the war service. While there are many standing committees covering different fields of scientific work, yet each member is a committee unto himself in co-operating with naval officers.

Through the vision of Secretary Daniels this board was created about one and a half years before the United States entered the war. This act of early preparedness resulted in the survey and listing of all the manufacturing industries of the country—a useful thing which had not been done before. That survey fully card indexed is now serving its purpose, bringing promptly and efficiently all the resources of the nation to the aid of the Army and Navy.

More than this should not be said at the present time of the work of this board. If any one would like to ask questions I shall be glad to answer them—after the war is over.

THOSE RIVETING RECORDS

It would really seem that somebody should be saying something about these astonishing riveting records which are tumbling over each other in the daily press. We all know that for the winning of the world war the supreme demand is for ships. In the building of the ships the most responsible and the most continuously repeated operation is the riveting. Therefore, of course, speeding up the riveting is speeding up the building and increasing the output of ships.

It is, at first thought, most gratifying to note that a lively rivalry is current throughout the shipbuilding plants on both sides of the Atlantic for the making of riveting records, these being taken, of course, as indexes and guarantees of shipbuilding speed. They may be; but are they? It was said of the Charge of the Light Brigade that it was very brilliant but it was not war. So, without questioning at all the veracity of the current riveting records, we are tempted to say that they may be very brilliant but they are not shipbuilding, if indeed, they can be called riveting.

A shipbuilding pneumatic riveting record is not the record of one operative alone handling a single pneumatic riveter, even with changes or replacements of the tool from time to time. The man usually will be the head of a co-operating gang of six, comprising, besides himself, a backer-up, two heaters and two passer-boys. The making of a pace-making riveting record involves also many more than this riveting gang, who alone get the credit. As suggesting the mass of coincident work involved it is to be noted that the holes must be instantly and constantly ready for the rivets, so the numerous sheets and other members must be successively assembled and clamped in place with all the holes matching absolutely so that every rivet will enter without hesitation, and to make sure of this a plug must be tried in each hole and many of the holes must be reamed. These preliminary operations must all be carried on without getting at all in the way of the riveters. With all these conditions suggested to be complied with, and remembering the minor interruptions which inevitably occur, we are invited at the present writing to believe that in nine hours a single riveter has driven a number of rivets amounting to one every six seconds for the entire period. It paralyzes our believing apparatus.

It would seem to be very difficult for us ever to accept records of individual riveters, such as those now current, as assurances of ultimate shipbuilding speeds. Riveting records of another class are now coming along more deserving of serious consideration. These are the collective records per week, or other period, of all the rivets driven by all the riveters employed upon a single ship or upon a single shipyard way. This would tell us a real story of real shipbuilding, and the record would really tell not only of the actual performances of the riveters but of the co-operation of all hands to produce the desired results.—*Frank Richards in the Iron Age.*

SOME RECORDS

A crew of 75 men at the St. John's shipyard recently caulked the hull of a schooner from keel to light load line and full length, 240 ft., in 8 hours.

A planking gang at the U. S. Shipping Board Yard, Jacksonville, Fla., in one day recently put in a total of 72 planks. There are 108 strakes of 16 planks each all around the ship, making a total of 1,728 planks in all. At the rate of 72 planks a day it would take a crew only 24 working days to complete the planking of a vessel.

A speed record for framing was made recently at the Portland yards of the Supple-Bollin Shipbuilding Co. A crew of 14 framers, 2 foremen and 4 riggers built and placed in position from lumber in the yards, 89 frames in 40½ hours. These frames, being double, were built, bolted together with 64 screw bolts in each frame, and two coats of carbolineum were applied before bolting together. At the same yard two gangs of five men each planked complete a 310-ft. hull, including garboard, 53 strakes of planking, in 27 days.

An attempt was made on 27th inst., at J. Crichton and Co., Limited's Shipyard, Saltney, near Chester, England, to establish a record for *hand* riveting. The squad engaged —Oakes, Edge and company—commenced at

6 a. m., intending to work in three shifts of three hours each. The weather was fine but hot. At 2.30 p. m., however, officials of the Boilermakers' Society intervened and stopped the men after 6½ hours' work. During this period, 2,007 ⅝-in. steel rivets had been driven into frames for ships' sides. When stopped, the men were perfectly fresh and very disappointed at not being allowed to complete the nine hours' record. An inspecting officer was present and the work was carried out to his satisfaction.

Driving 12,209 rivets in nine hours into a standard ship was the feat accomplished at the yards of Workman & Clark, Belfast, Eng., recently by John Omir, who beat the hour record for the United Kingdom. In his work Omir drove in more than a thousand rivets every hour and on two occasions passed the 1,400 mark. In his best minute he drove 26 rivets. Omir used about two and one-half tons of metal.

Concerning the item immediately preceding, it would be convenient to be permitted to employ the familiar dictum of the ladies—"Too ridiculous for anything."

PROGRESS OF LIQUID OXYGEN EXPLOSIVES.

Owing to the shortage of ordinary explosives for mining purposes in Germany, due to war requirements, considerable extension has been given to the development of oxyliquite, or "sprengluft" (explosive air). Several firms in Germany, working Linde's and other patents, have experimented with apparatus and effected considerable improvements in the practical application of the system for mine blasting. *Le Génie Civil* for June 1st describes some of these developments, and the following notes are taken from that journal.

The principal firm interested in the process is the Sprengluft Gesellschaft m.b.H., which has lately developed plants capable of supplying 10 kilos. (22 lb.) of rectified liquid oxygen per hour. The net cost price is said to be something under 2½d. per kilo., including interest and depreciation charges.

For storing the liquid oxygen, a modification of the Dewar flask is used, and is generally constructed in brass or very thin steel. In order to maintain the rarefaction of the space between the two walls, this space is filled up with charcoal. When the vessels are filled, the temperature between the two walls is—190 deg. Cent., the normal boiling point of liquid oxygen. The porous charcoal absorbs any small amount of gas which may escape through the pores of the metal.

In utilizing the liquid oxygen for explosive purposes, a number of combustible materials have been tried, but lampblack has been found to be the most satisfactory. In practice, cartridge cases of convenient sizes for insertion in the bore-hole are prepared in cardboard, into which the lampblack is introduced. A long tube (also of cardboard) is let into the case and through it the oxygen is poured. The most satisfactory way of charging the cartridges is to immerse them for some time in a tank containing the liquid oxygen so as to allow them to become thoroughly impregnated. The cartridges are constructed in such manner as to give as little loss as possible between the process of immersion and insertion in the bore-hole. The best types can be kept for 8 to 10 minutes after leaving the immersion tank. The cartridges are usually exploded by a small primer ignited either by a fuse or electrically, electric ignition being preferable on account of its greater efficiency.

Oxyliquite has proved very efficient in mining operations by reason of its *brisant* properties, but for the same cause it is not so suitable for quarry work. It has also been successfully used under water in the demolition of a bridge over the Danube. It is claimed that the chief company concerned with the exploitation of the process is able to supply annually the equivalent of 10,000 tons of nitrate explosives. One advantage claimed for this method is that it is safer than the explosives generally used, since the cartridge is only explosive for 10 minutes, *i. e.*, from the time it is saturated with the liquid oxygen to the time it is exploded. The only disadvantage in the system would seem to be that it is necessary to install a liquid oxygen plant near the scene of operations. The labour required to carry out the process has also to be very skilled. Comparing oxyliquite with other explosives, it is stated that dynamite has a greater density of charge than oxyliquite, but, weight for weight, the latter is more effective than dynamite.—*The Engineer.*

COMPRESSED AIR DEFINITIONS

The Compressed Air Society, 30 Church St., New York, L. D. Albin, Secretary, sends out the following definitions recommended by the Technical Committee of the Society:

Displacement.—The displacement of an air compressor is the volume displaced by the net area of the compressor piston.

Capacity.—The capacity should be expressed in cubic feet per minute and is the actual amount of air compressed and delivered, expressed in free air at intake temperature and at the pressure of dry air at the suction.

Volumetric Efficiency.—Volumetric efficiency is the ratio of the capacity to the displacement of the compressor, all as defined above.

Compression Efficiency.—Compression efficiency is the ratio of the work required to compress isothermally all the air delivered by an air compressor to the work actually done within the compressor cylinder as shown by indicator cards, and may be expressed as the product of the volumetric efficiency, (the intake pressure and the hyperbolic logarithm of the ratio of compression), all divided by the indicated mean effective pressure within the air cylinder or cylinders.

Mechanical Efficiency.—Mechanical efficiency is the ratio of the air indicated horsepower to the steam indicated horse-power in the case of a steam driven, and to the brake horse-power in the case of a power driven machine.

Overall Efficiency.—Overall efficiency is the product of the compression efficiency and the mechanical efficiency.

The Society further recommends that the use of other expressions of efficiency be discontinued.

UNIFICATION OF GAS WARFARE WORK

Following the recent transfer of work on war gases from the U. S. Bureau of Mines to the War Department, a further step toward unifying all work of this sort was taken by Secretary Baker in ordering that all classes of gas warfare hereafter should be under the control of the Chemical Warfare Service, commanded by Maj. Gen. William L. Sibert. Divisions in the Medical Department, the Ordnance Department, as well as in the Bureau of Mines, have been handling it in the past. All officers and men who have been connected with offensive or defensive gas warfare will now be responsible to the Chemical Warfare Service. The field-training section has been under the corps of engineers.

Defensive gas warfare has been under the control of the Medical Department. The work has consisted of the designing and manufacture of masks, both for men and animals, and the procurement of appliances for clearing trenches and dugouts of gas. Offensive gas warfare consists principally of manufacturing gases and filling gas shells. The work has been under the direction of the Ordnance Department. The new department will take over the work of chemical research for new gases and protection against known gases. All chemists now in the Army will be transferred to the new service.

HIGH AIR PRESSURE IN TUNNEL WORK

Driving subaqueous tunnels at New York is now an old story and little concerning the work gets into the papers. Nevertheless the business is as active as ever, there being four tunnels advancing under the East River at the present time. In the construction of one of these, at 60th Street, a maximum working pressure of 47 pounds, gage, has been reached. More than 25 years ago, about half a mile north of this tunnel a gas main tunnel was driven, the first of all the East River tunnels, and in that for a short time a pressure of 52 pounds was reached with a number of fatalities due to the lack of knowledge of proper treatment which has since developed.

The high pressure in the 60th Street tunnel is on account of the great depth—more than 100 feet—at which the tunnel is being dug. This low point was required because of the depth of the west channel of the East River between Blackwell's Island and the Manhattan shore. In order to cross this channel it was necessary to obtain permission of the United States Government to place a false bottom under the West Channel, which was done by depositing more than 60,000 cu. yd. of clay and riprap. The men work only two shifts of 45 minutes each in the 24 hours, and are paid, it is said, $7.50 per day. In order to keep the work going sixteen shifts of men are employed. The men in coming out spend 15 minutes in a first lock, where the pressure

is reduced to 20 lb., then a few minutes are taken in walking an intermediate chamber 1800 feet in length, and 20 minutes is spent in an outer chamber where the pressure is gradually reduced to normal. Similar precautions are observed in entering the tunnel.

WHEN CARBON MONOXIDE IS FATAL

Carbon monoxide has an avidity for hemoglobin, the red coloring matter of the blood, with which it forms the same combination as does oxygen, only 250 times as powerful. However, this combination is not permanent and a man brought out to the fresh air, or to whom air mixed with oxygen can be administered, will generally recover if exposure is within the following limits. As a rough estimate, it may be stated that usually a man will die who has breathed 0.2 per cent. of carbon monoxide mixed with air which is in other respects normal, for four or five hours, or 0.4 per cent. for one hour. With from two to five per cent. of carbon monoxide death follows almost as quickly as in drowning.—*Journal of the American Medical Association.*

NOTES

Sir Douglas Haig recently celebrated his fifty-seventh birthday. An older brother, John, a mining engineer at a talc mine at Eldorado, Ontario, enlisted at the age of sixty, obtained a lieutenancy without influence, and was promoted captain. Not until he had been in the trenches for months did he meet his brother, who did not know he was at the front.

A peculiar accident caused the death of a laborer in a rock quarry at Rochester, N. Y. The man was on top of a chute, pushing stone down into a car loaded by his companions, when he lost his footing and fell. He retained his hold on his shovel and the tool caught the sides of the chute and held him, while tons of rock fell on him.

A labor-saving device now being employed at the Portland yard of the Foundation Company in Oregon, is described in the official organ of that organization as follows: "You are all familiar with the fact that salt is placed between the ceiling and planking of all wooden ships to preserve the wood above the water line. Heretofore the planking has been delayed because the salting has not been done. Science now steps forward with a new wrinkle for salting a ship. The method requires the use of an auger, a tin box, an air jet and a couple of men. A hole is bored through the ceiling outside of which a tin box filled with salt is placed, and inside the box of salt is injected the air jet. The salt is quickly blown into the many pockets formed between the ribs."

Five workmen were killed outright and another was seriously injured in an explosion that occurred June 26, in the tunnel being driven for the East Bay Water Co., Oakland, Cal., by Bates & Borland, contractors. The heading had been advanced about 1500 ft. and some previous difficulty with gas had been experienced. The five men killed were working at the heading; the sixth man, operating a storage battery locomotive, was some distance from the heading. It is believed that a spark caused by the striking of a pick on rock may have ignited the gas. The explosion caused a cave-in which prevented rescuers from bringing out the bodies until the debris had been excavated.

Materials for one mile of first and second-line trenches and communication-trenches on the British front, according to C. G. Martin of the Royal Engineers, include the following: 900 miles of barbed wire for entanglements, weighing 110 tons; 12,000 standards 6 ft. high; 12,000 small pickets; 6,250,000 sandbags, weighing 1000 tons; 36,000 sq. ft. corrugated iron; 1,125,000 ft. B. M. lumber.

Experiments are now being made in Norway to operate automobiles with acetylene gas. No gasoline has been obtainable for many months, and practically no automoblies have been running. If the motors can be made to use acetylene gas, it can be manufactured in considerable volume from calcium carbide, which is produced in large quantities in Norway by means of the water power.

The temperatures attained in the cylinders of gas-engines may vary considerably, but in some instances, at the top of the explosion-stroke, the temperature is 2,700 degrees F., with a minimum, during suction-stroke, of 250 degrees, and an average of 950 degrees dur-

ing the complete cycle. These are the temperatures of the gases in the cylinder, not of the cylinder-walls.

A tunnel a mile long will be a novel feature on the highway to be built between Clark's Summit and New Milford, Pa. The road will be built upon right-of-way released by the D., L. & W. Railroad Company.

Mosquito reduction, which is rightly receiving considerable attention, but deserves far more, is primarily an engineering problem. The first point of attack should be the removal of breeding places by drainage. Oiling is a mere palliative, although often necessary until drainage can be effected or where for any reason it cannot be successfully carried out. Successful control under the most trying conditions shows that there is no excuse for the mosquito pest and danger in this country.

According to the *Electrical Experimenter*, all institutions depending upon the Marion (Ind.) Electric Light and Power Service were without current for a minute recently, and all because John Coats, who takes his regular Saturday evening bath at his home, got hold of a live wire in attempting to shake into life a defunct electric-light globe, and could not let go. Standing in the water with a 110-volt current coursing through his body, all Coats could do was to yell for help. A neighbor quickly discovered his plight, and telephoned the light company, who turned off all current. Coats was injured only in feelings.

The total power now being generated on both sides of Niagara is 653,500 h.p. Of this amount 265,000 h.p. is generated in the United States, which also receives 110,000 h.p. exported from the Canadian side, making a total of 375,000 h.p. available in the United States. This amounts to 40 per cent. more for the United States than for Canada, although the latter country generates 100,000 h.p. more than the United States. There is no intention on the part of either the Canadian Government or the Commission to interfere with the present export arrangement, even though Canada is now short 100,000 h.p.

Condemnation of well waters as the result of inspections and analyses by the Illinois State Water Survey for the nine-year period from 1907 to 1916 shows that as the depth of the wells increases the percentage condemned as unsafe decreases. During the period named 11,281 wells were examined and of these 5,091, or 45 per cent, were condemned. For wells less than 25 ft. deep the percentage of condemnation was 74; 25 to 50 ft., 63; 50 to 100 ft., 36; more than 100 ft. deep, 14. Of wells with unknown depths the percentage of condemnation was 44, the total number of wells being 636.

The Channel Tunnel, said Sir Arthur Fell at a meeting of the London Society, will be the earliest and greatest of all the works of peace which will be begun immediately the war is over, and when labor and materials have become available. It will be the first monument to the new era of peace, and to an enduring friendship with the immortal race which for four years has been fighting by our side for the liberty of the world. This link will unite the two nations in a permanent bond that will enable the two peoples to know each other better, and to appreciate one another more.

Dr. Charles P. Steinmetz, of the General Electric Company, predicts the ultimate use of all the hydraulic power that can be generated at Niagara. His suggestion is that Niagara should be developed completely, say, to about 10,000,000 kw., making the falls run dry; but that the power plants should be shut down, say, to 10 per cent. of full capacity, on holidays and Sundays, allowing the falls to resume their natural form for the benefit of visitors. The recent experiences in fuel and power shortage, and the possibilities of railway electrification and electro-chemical and electro-metallurgical work, will sooner or later force all to agree that some such scheme is demanded in the national interest.

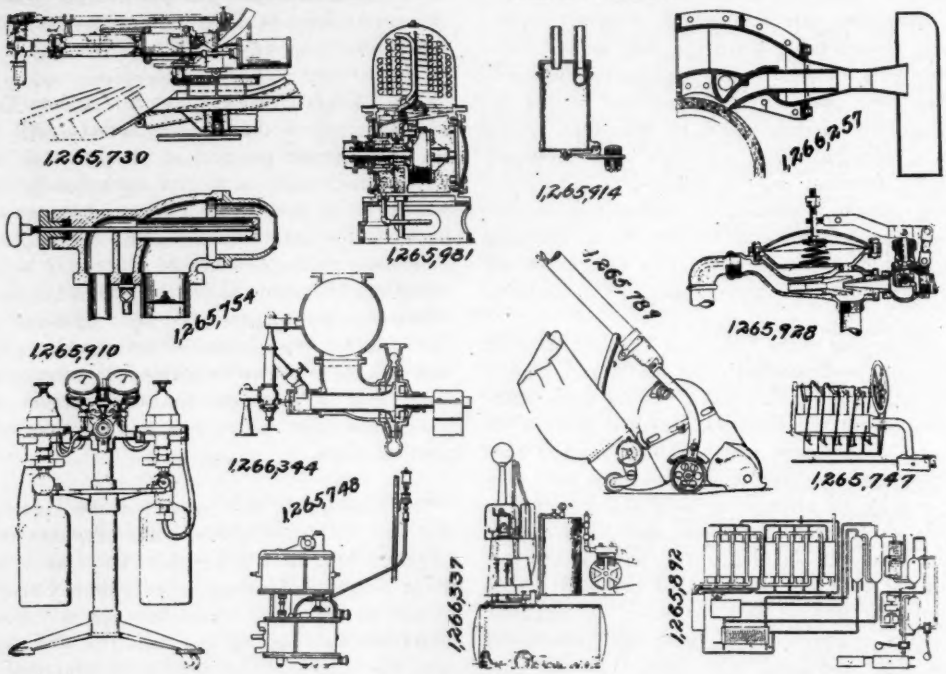
LATEST U. S. PATENTS

Full specifications and drawings of any patent may be obtained by sending five cents (not stamps) to the Commissioner of Patents, Washington, D. C.

MAY 14

1,265,730. LOADING OR MINING AND LOADING MACHINE. Frank Billings, Cleveland, Ohio.

1,265,747. AIR-MOTOR. Melville Clark, Chicago, Ill.
1,265,748. LUBRICATING DEVICE. Nelson T. Cline and Robert M. Long, Pittsburgh, Pa.
1,265,754. OIL-BURNER. Albert Deem, Indianapolis, Ind.
1,265,789-10. VACUUM CLEANING-MACHINE. James B. Kirby, Cleveland, Ohio.
1,265,892. METHOD AND APPARATUS FOR SEGREGATING AND RECOVERING GASES. Frederic Augustus Eustis, Milton, Mass.
1,265,908. PNEUMATIC ELEVATOR AND DISTRIBUTER FOR COTTON-GINS. Joseph Luther Hart, Chickaska, Okla.
1,266,566. BAROMETRIC VALVE. Earl E. Eby, Wilkinsburg, Pa.
1,266,624. RESPIRATOR. Hubert H. Ramsay, Tylertown, Miss.
1,266,697. MILKING-MACHINE. Arthur C. Macartney, Chicago, Ill.
1,266,795. MILKING-MACHINE. Carl Jacob Johan Hagg, Stockholm, Sweden.
1,266,864. DOOR CHECK AND CLOSER. John C. Schmidt, Chicago, Ill.
1,266,966. HUMIDIFYING-FAN. Willard M. McEwen, Chicago, Ill.
1,266,976. VACCUM-BREAKER. Harry E. Morton, Boston, Mass.
1,267,040. FLUID-PUMP. Charles A. Anderson, Chicago, Ill.



Pneumatic Patents May 14

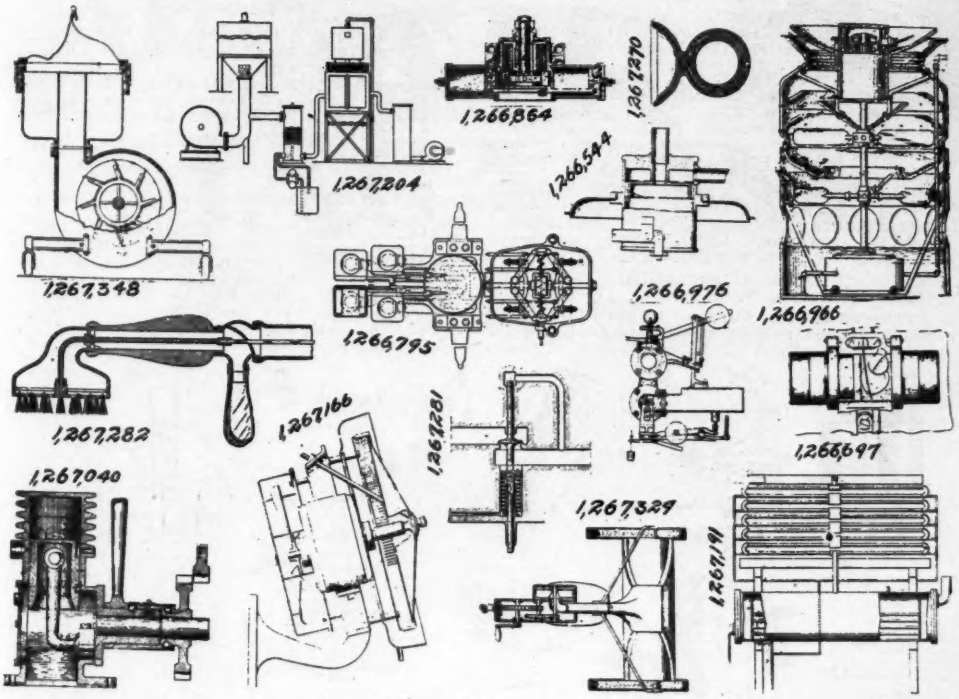
1,265,910. APPARATUS FOR DELIVERING A MIXTURE OF GASES. Jay A. Heidbrink, Minneapolis, Minn.
1,265,914. MILKING-MACHINE. Arthur V. Hinman and Ralph L. Hinman, Oneida, N. Y.
1,265,928. HEATING SYSTEM AND HYDRAULIC VACUUM-GENERATOR. Bryce W. McClymont, Detroit, Mich.
1,265,981. GAS-COMPRESSING APPARATUS. Edward T. Williams, New York, N. Y.
1,265,997. PNEUMATIC POWER-BOAT. Geo. W. Christoph, Warehouse Point, Conn.
1,266,257. SEPARATOR AND CONVEYER FOR PAPER-PULP MACHINERY AND OTHER PURPOSES. Anton J. Haug, Nashua, N. H.
1,266,337. APPARATUS FOR SUPPLYING GASOLINE AND COMPRESSED AIR. Harry F. Smothers and Emanuel E. Norquist, Kansas City, Mo.
1,266,344. CONDENSATE AN AIR REMOVING APPARATUS. Robert Suczek, Philadelphia, Pa.
1,266,482. AIR-CUSHION. Harris Kamrass, New York, N. Y.

MAY 21

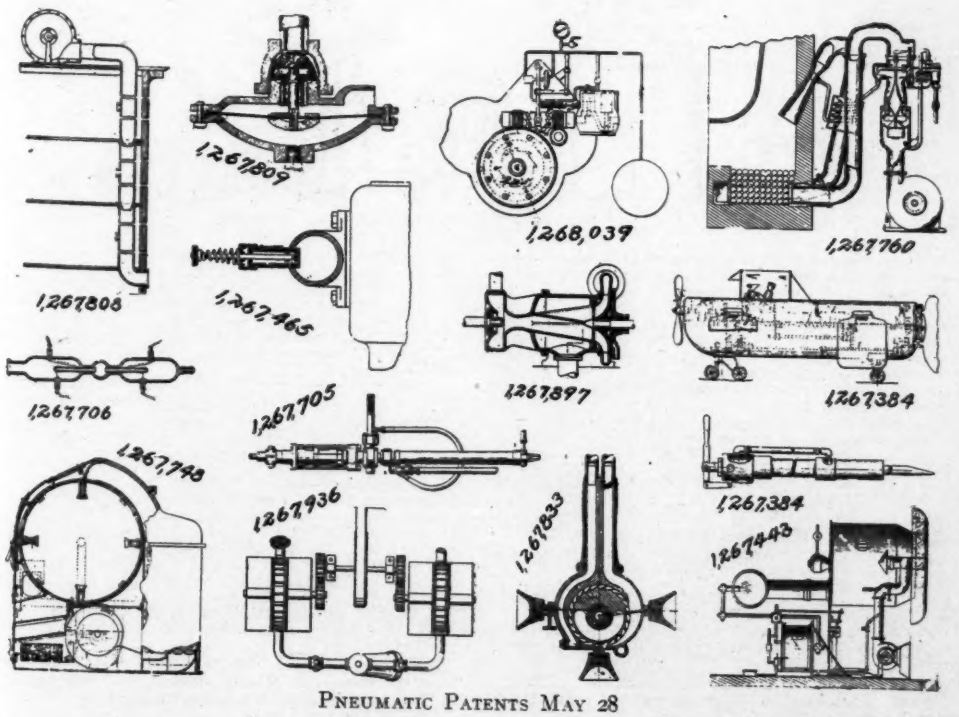
1,266,544. MILKING-MACHINE. Carl Oscar Anderson, Lancaster, Pa.
1,267,160. AIR-COOLING SYSTEM. George E. Albin, Cornish, Okla.
1,267,166. HUMIDIFIER. Frederic F. Bahnson, Winston-Salem, N. C.
1,267,191. PROCESS AND APPARATUS FOR DEAERATING WATER. Herman J. Demuth, Kiowa, Kans.
1,267,204. METHOD OF DEODORIZING GRAIN. Walther Frick, Hochst-on-the-Main, Germany.
1,267,229. ELASTIC-FLUED TURBINE. Oscar Junggren, Schnectady, N. Y.
1,267,270. VACUUM-CUP. Rudolph Paul Rheinlander, St. Louis, Mo.
1,267,281. PRESSURE-REDUCING APPARATUS FOR FLUIDS. Eugene Schneider, Paris, France.
1,267,282. VACUUM HAND-BRUSH. Jessie B. Scully, Kansas City, Mo.
1,267,329. VACUUM-SWEEPER. Jerry J. Merithew, Akron, Ohio.
1,267,348. MOBILE SUCTION-CLEANER APPARATUS. Charles D. Lanning, Boston, Mass.

MAY 28

1,267,384. FLYING-BOAT. Leonardo Crimaudo, New York, N. Y.



PNEUMATIC PATENTS MAY 21



PNEUMATIC PATENTS MAY 28

1,267,443. MEANS FOR AUTOMATICALLY REGULATING THE BLAST COMPONENTS OF PRODUCERS. Hugh T. Newell, Pittsburgh, Pa.

1,267,465. AUXILIARY AIR-INLET VALVE. John H. Schmidt, Detroit, Mich.

1,267,698. PNEUMATIC TOOL. Addo M. Roberts and Edwin G. Williamson, Greenville, Pa.

1,267,705. ROCK-DRILL. William A. Smith, Denver, Colo.

1,267,706. VACUUM REGULATION. Homer Clyde Snook, Oak Park, and Edwin W. Kelly, Chicago, Ill.

1,267,748. DRYING APPARATUS. Edward I. Cutter, Norwood, Ohio.

1,267,760. LIQUID-FUEL COMBUSTION. John Good, Brooklyn, N. Y.

3. The method of burning liquid fuels which consists in controlling the liquid fuel and air in the proportions of an explosive mixture

JUNE 4

1,268,079. REGULATING MECHANISM FOR CENTRIFUGAL COMPRESSORS. Otto Banner, Easton, Pa.

1,268,081. FLUID-OPERATED PERCUSSIVE TOOL. Lewis C. Bayles, Easton, Pa.

1,268,095. TURBINE FAN-BLOWER. Charles T. Coe, Kearney, N. J.

1,268,128. MEANS FOR SUPPLYING AIR TO GAS-ENGINES. Charles L. Kurtz, Columbus, Ohio.

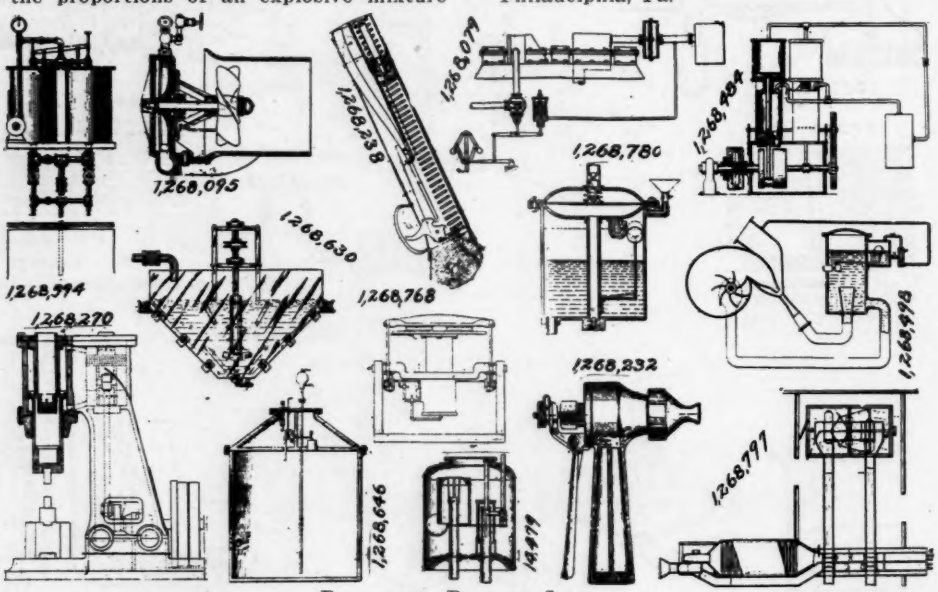
1,268,232. SPRAYING DEVICE. George B. Furman, East Orange, N. J.

1,268,238. AIR-GUN. William B. Greenleaf and Ernest S. Roe, Plymouth, Mich.

1,268,270. FLUID-POWER HAMMER. Ralph W. Nazel, Philadelphia, Pa.

1,268,272. ELASTIC-FLUID TURBINE. Earle R. Newton, New York, N. Y.

1,268,403. AIR-BRUSH. Ernest C. Stacker, Philadelphia, Pa.



PNEUMATIC PATENTS JUNE 4

of such liquid fuel, heating said proportioned air and then finely atomizing and mixing the proportioned liquid therewith to form a blast mixture, and directing said mixture against a combustion-locating bed at a velocity, between its place of formation and said bed, which exceeds the rate of flame propagation through said mixture, whereby the locus of the combustion is established and maintained in or on said bed.

1,267,808. DEVICE FOR VENTILATING HOTELS AND OFFICE-BUILDINGS. William R. Self, Newton, N. C.

1,267,809. VACUUM-VALVE. Wilfred Shurtleff, Moline, Ill.

1,267,833. FLUID-ACTUATED VIBRATOR. Charles P. Wilson, Chicago, Ill.

1,267,880. CENTRIFUGAL COMPRESSOR. William J. McBride, Lynn, Mass.

1,267,897. AIR-PUMP. Gustav Pagel, Berlin, Germany.

1,267,936. HYDRAULIC AIR-COMPRESSOR AND MOTOR. Christian Carl Tuch, Honolulu, Hawaii.

1,268,039. PNEUMATIC STARTING DEVICE FOR INTERNAL-COMBUSTION ENGINES. John E. Miller, Moline, Ill.

1,268,434. PNEUMATIC ENGINE-STARTER. Barney Christiansen, Slater, Iowa.

1,268,467. PRESSURE CONNECTION AND GAGE. Carl I. Jacobson and Alfred L. Fowler, Los Angeles, Cal.

1,268,498. PUMP OR COMPRESSOR. Arthur Edwin Leigh Scanes, Ashton-on-Mersey, England.

1,268,594. APPARATUS FOR ELEVATING LIQUID. James A. MacKenzie, Rochester, Pa.

1,268,630. AERATING DEVICE. Joseph P. Ruth, Jr., Denver, Colo.

1,268,646. LIQUID-FOUNTAIN. Adolf P. C. Urbin, Jr., Mount Vernon, N. Y.

1,268,738. ELASTIC-FLUID TURBINE. William J. A. London, Springfield, Mass.

1,268,768. MOLDING-MACHINE. Emlen P. Pitfield, Cambridge, Mass.

1,268,780. VACUUM FEED DEVICE FOR ELEVATING LIQUID. Webb Jay, Chicago, Ill.

1,268,797. APPARATUS FOR DRYING AND THE LIKE. August Tegoli, San Francisco, Cal.

14,479. (Reissue). AIR-LIFT-PUMP BOOSTER. Frank S. Miller, deceased, Indianapolis, Ind., by William Langsenkamp, Jr., trustee, Indianapolis, Ind.